The aim of science lies clearly mapped before us: to learn more and more about the initial conditions; to know better and better the laws of nature; to penetrate deeper and deeper into the mathematical formalism. These are the keys that will open the past and the future of our universe.—"Whom the Gods Love" *by* LEOPOLD INFELD.

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THE CALL OF A MAGNIFICENT CONVENTION PROGRAM

Plans are now realities, dreams have come true, and we can, again, promise you an "electrifying" convention program. So we say:

INDIANAPOLIS INVITES YOU TO A HEADLINER 1948 CONVENTION

Renowned scientists, discoverers, and educators will bring messages on the miracles of silent Antarctica, on the mysteries of the great Mid-Atlantic Ridge, on America's aid to education in devastated Europe, on new thoughts in teaching of mathematics and science. A whole group of prominent educators will bring in the Third Annual Forum of the AAAS Cooperative Committee the problems of teaching science and mathematics as part of general education. When the program was dreams, it was said, "Impossible!" Here it is, a reality, your 1948 convention program.

Besides these major offerings, eight sections and five groups present outstanding men and women in their programs to bring reports on latest discoveries, and the latest thoughts in teaching techniques. And our exhibitors offer in their displays a liberal education. I venture the claim that nowhere can teachers get such a program as *a gift to their membership*. Besides, the Central Association of Science and Mathematics Teachers convention is like a cheerful homecoming where one greets friends from many states; it is an opportunity to meet and associate with outstanding educators, authors, administrators, and the men and women whose lives are woven into the same teaching field which has claimed yours.

You cannot afford to miss such a convention! Plan to come and tell the young teachers in your school about membership in CASMT

and its stimulating convention in Indianapolis on November 26 and 27.

J. E. POTZGER, *President*,
Butler University,
Indianapolis, Indiana

BLUEPRINT OF A DREAM

A few years ago some members of Central Association had a new dream. It was stimulated by a look at the calendar. They were reminded that in 1950 our great organization will be fifty years old. A half century of growth and service will have passed.

"We must celebrate," they said.

Some members were asked to study possibilities and to suggest ways and means. During the past three or four years, numerous discussions have been held and many letters have been written. Sometimes the dream seemed impossible of effective realization; now we are assured of its materialization. It has reached the blueprint stage. You will be hearing more and more about it.

One major part of the plan for the observance of our fiftieth anniversary in 1950 is the publication of a volume which will summarize the development of organization and teaching of science and mathematics in America during the eventful half century of the existence of Central Association. Final plans for the volume are rapidly nearing completion and actual writing is under way. The volume should be one of wide usefulness and influence and a source of renewed pride to the great organization responsible for it.

It is your book. We want you to grasp this fact now. We hope you will look forward to seeing it. We want you to talk about it, spread the word that it is coming.

A NEW DEPARTMENT AT STANFORD

A new Department of Statistics will be instituted at Stanford University this fall, it was announced today by Dr. Alvin C. Eurich, acting president.

The department was created to meet the growing need for competent statisticians in government, industry, and universities. It grew out of recommendations from the faculty committee on statistics, which over a period of years has been responsible for coordinating instruction in this field.

The functions of the new department will include training in statistics at undergraduate and graduate levels, research in statistical theory and techniques, and consultation on statistical aspects of university research.

Students will study pure mathematics, mathematical statistics, and fields in which statistical methods can be applied.

CLARENCE E. COMSTOCK

1866–1948

Clarence E. Comstock was one of the first members of the Central Association of Science and Mathematics Teachers. He took a very active part in its development and was one of the first contributors of articles appearing in 1903 in the new "Mathematical Supplement of School Science." The other contributors in this issue were the nationally known mathematicians E. H. Moore, David Eugene Smith, Arthur C. Lunn and W. W. Beeman. He was well known in the Association and became the third president.

Professor Comstock was born in 1866 at Galesburg, Illinois. His father, a professor of mathematics in Knox College for forty years, was highly respected and known as a serious-minded and scholarly man. He was a great influence in the life of his son.

Clarence E. Comstock received an A.B. degree from Knox College in 1888 and an A.M. degree in 1891. The same institution recognized his services by conferring upon him an honorary degree of Doctor of Science in 1931.

After receiving the masters degree he spent two years doing advanced work at Johns Hopkins and one at the University of Chicago. He then entered the teaching profession and after an experience of several years he accepted a professorship at Bradley Institute, Peoria, Illinois. He was head of the mathematics department until his retirement in 1939.

Professor Comstock sponsored many of the recommendations for the improvement of the teaching and organization of secondary school mathematics. In his own department he was free to try out some of these recommendations and to conduct experiments. Thus he brought about a close relationship between the mathematics department and other departments of the school by organizing courses in such a way as to enable pupils to use their mathematics when needed in other school subjects. He organized one of the first "mathematical laboratories" in the country. Many experiments formerly performed in physics, chemistry, and the shops were transferred to this laboratory, and pupils performing them received full credit in their courses.

It was to be expected that this type of planning would result in the development of textbooks and in time he became the author of a number of textbooks in elementary algebra and plane and solid geometry.

Professor Comstock's devotion to his subject is evidenced by the active part he took in several national associations. He was a member of the American Mathematical Society, the Mathematical Associa-

tion of America, the Society for Promotion of Engineering Education, and the Central Association of Science and Mathematics Teachers.

His active and productive life came to a close with his death on April 3, 1948 in Peoria, Illinois. His students and coworkers are lossing in him a great teacher and true friend.

E. G. BRESLICH,
University of Chicago

GEORGE W. HUNTER

Dr. George W. Hunter of the Claremont Colleges, Claremont, California died February 4, 1948. Doctor Hunter was a member of the Central Association for many years and a leader in biological and general science education. He was the author of a number of texts and made many contributions to educational journals.

MAE R. ANDERSON

On March 28, 1948 the Central Association lost another leader by the death of Dr. Mae R. Anderson of Concordia College, Moorehead, Minnesota. She became a member of the Mathematics section of the Association in 1945.

ANNOUNCEMENT OF AMERICAN COUNCIL ON EDUCATION'S 1949 TEACHER EXAMINATION PROGRAM

Arrangements may now be made for the establishment of examining centers for the tenth annual administration of the American Council on Education's National Teacher Examinations.

The Teacher Examinations are administered through the facilities of the Educational Testing Service, and examining centers are conducted in cooperation with school systems and teacher education institutions.

Many superintendents and boards of education require or advise applicants for teaching positions to present National Teacher Examination records. The examination results are used as *one* of the factors in teacher selection.

The Teacher Examinations also are administered in connection with teacher education programs in colleges and universities, both at undergraduate and graduate levels.

Used in combination with additional information such as that provided by records of experience, academic marks, ratings of various aspects of personality, etc., the Teacher Examination results can contribute materially to the raising of standards of teaching.

The American Council on Education welcomes the use of its Teacher Examinations by any school system or college, *provided* assurance is given that the examination results will be *used wisely in combination* with other significant information concerning the prospective teacher.

Arrangements for the establishment of examining centers should be made by superintendents of schools and college officials before November 15, 1948. Correspondence regarding cooperation in the project may be addressed to: Director, National Teacher Examination Project, Educational Testing Service, 15 Amsterdam Avenue, New York 23, New York.

PHANTOM FORESTS*

J. E. POTZGER
Butler University, Indianapolis, Indiana

It is a rather common statement of people to say, "We are living in a changing world," but few, if any, of these persons voicing such an opinion on this great scientific truth realize how complete and far reaching changes have been during the past. Neither do most of them realize that the changing world involves both the biological and the physical forms and phenomena.

The paleobotanist and the geologist not only recognize these phenomena but they make an effort to reconstruct the past life from the fragmentary tell-tale records left in the rocks or in the sediments of lakes and ocean basins. A tooth, a track, a whole skeleton (at the best), a shell, a tusk, perhaps a mass of carbonized plant remains, all serve as concrete evidences of the life of the past ages. In more recent times we have included in such informational records the pollen dust of "phantom forests" of the past which is found buried deep in the muds of lakes and bogs. Whole series of such pollen records from a single lake or bog are called pollen profiles. These pollen profiles also record great climatic changes as well as the coming of mighty vegetations. In many instances these were later completely replaced by a different forest type so that frequently not a single trunk remains to speak for the ancestral glory. Phantom forests of the past may, thus, rest in silence between layers of rocks or in the mud of ancient and present-day lakes as record of and tribute to the age when they were a ruling tree association.

Let, us then, consider in more detail the most recent paleobotanical investigation, the pollen analysis method. This concerns itself mostly with the more recent past in glaciated areas, the times following the great ice invasions, also called post-Pleistocene. Research of the writer and of fellow workers centers in the forest movements following the gradual wasting of the ice sheets of Pleistocene times which had pushed southward their annihilating frigid tongues even into the Ohio valley. Glaciers veneered the landscape with new soils, which in many localities reaches a depth of 200 to 400 feet. They rode mercilessly over the vegetation of that day until not a single tree remained. Well drillers and excavators of today meet remnants of these slaughtered forests buried deep in glacial till. Thus, vegetation had to begin from "scratch" on the new soils. Pollen records tell about the path followed by the northward or westward advancing conquering forests, as climate favored first one and then another

* The subject matter of this paper was presented as an address before the Biology Section of the 1947 convention. The author expresses sincere thanks to Mrs. Esther Whitney Potzger for illustrations in Fig. 2.

group of genera and species; in this way pollen profiles also give testimony as to changes in climate and behavior of forest types. We can even gather considerable information about individual genera and species.

Pollen analysis made its debut in North America about 25 years ago. This method of paleobotany permits both a qualitative as well as quantitative interpretation of the forest composition of the past and the changes which have taken place.

Glaciers are the direct cause of more lakes than any one other physiographic disturbance. Lakes are excellent archives for records of passing events in the plant life of a given region. In their basins are collected microscopic plant remains, but especially wind-carried pollen grains, and these in turn become a part of the ever-deepening sediments, arranged in chronological order, until the lake turned to bog and trees invaded the solidifying surface. At this stage waves no longer gathered pollen dust for records of that age, the book had closed.

By taking samples of the lake and peat sediments and studying the pollens contained in them one can plainly see how the development of forests and their replacement by invading species progressed. When climate changes, a new generation of forest association is favored. Invading species are first represented by a very sparse pollen number, and in some cases they increased in frequency (see Fig. 1 for spruce, pine, oak). When such genera contributed most of the pollen in the lake sediments we are no doubt justified to assume that they also were at such times the most abundant tree genera in that area. If replacement occurred, the numbers of pollen grains for the less favored genus gradually or abruptly (see spruce in Fig. 1) decreased until in some instances they disappeared entirely (Fig. 1). Such records are very dramatic and show the story more clearly than one could have observed it in person while the elimination was in progress, for centuries of life activities are compressed into a few feet or even into a few inches of sediments, in this way gradual change is magnified.

This gradual increase and decrease of amount of pollen of a given species in lake sediments can be portrayed impressively on graphs. These show at a glance the changes in the crown cover which have taken place in the forests of a given region (Fig. 1). Since forest types are controlled by climate, pollen profiles also show climatic changes. Thus spruce indicates a cool-moist climate, pine a cold-dry, oak a warm-dry, and mixed mesophytic broadleaved forest (beech, maple, walnut, oak, elm) a moist-warm climate.

The pollen analysis method was first developed in Sweden; from there it spread to continental Europe and finally it was also intro-

duced in the United States. Until recently only a few workers were active in this field of research in North America but since the close of the last war the number of pollen analysts is on the increase, and pollen profiles are appearing in print from ever widening geographical locations. Needless to say, this also enables us to get a better understanding of the changes which have taken place, and of the climatic factors which induced them.

Until very recently studies were limited to borings from bogs but Dr. Ira T. Wilson developed a fine instrument for sampling of sediments from present-day lakes, and now pollen profiles from lakes have appeared. In many respects they are more complete than those from bogs. My own studies include records from bogs and lakes from Minnesota, northern Wisconsin, Upper and Lower Michigan, Indiana (both Early and Late Wisconsin glaciation), and in eastern coastal areas from New Jersey and Maine as well as an extensive study in Quebec. South of glacial borders a study was made of four bogs near Austin, Texas.

For field sampling two types of borers are in general use: the Swedish Hiller borer and the American Davis borer. The latter is a punch-type instrument while the Hiller type is a cylinder open on one side which can be closed by a 180 degree rotating sleeve. As previously stated, in very recent years Dr. Ira T. Wilson of Heidelberg College at Tiffin, Ohio, has developed an ingenious borer which can be used for sampling of sediments in still existing lakes. He operates from a large raft. His deepest borings to date were made in Douglas Lake, Michigan, where he took samples at one-foot intervals to a depth of 100 feet. These sediments were covered by water 100 feet in depth. (For description of his instrument see *American Midland Naturalist*, vol. 25, 272–274, 1941.) Usually samples are taken at one-foot intervals, but when sudden changes in type of sediments occur samples may be taken at more frequent intervals. Two or three ounces of the peat, or lakesediment, are placed into a small bottle on which location and foot-level are accurately indicated, and these are then stoppered securely. In the laboratory the peat is by some workers boiled in KOH and then centrifuged, or it may simply be dissolved in 95 per cent alcohol, as by the Butler group. A differential stain, like gentian violet, is added to make the pollen grains stand out more prominently which makes the tabulation easier. A small amount of the solution is then mounted in glycerine jelly. Pollen counts are made from these slides. Customarily 200 pollen grains are counted and tabulated at any one foot-level and results are expressed in terms of percentage. This shows to some degree the tree genera represented in the forest, and to some degree this indicates also the genera of trees which were most important and abundant in those forests of the past. Unfor-

FIG. 1. Pollen profiles representing types of forest development in Indiana and Michigan, a north-south distance of 500 miles.

tunately insect-pollinated trees seldom have their proper representation in the pollen dust as compared with wind-pollinated species, which produce much more pollen in comparison to insect-pollinated genera. The results of the count are shown as graphs (Fig. 1), where the important genera stand out prominently by longer graph lines at any one foot-level.

The most important thing for a pollen analyst is the ability to recognize the various pollens which may be present in the sediments. Differentiation may be based on shape, or on markings of the exine, or on the number of openings (germ pores), or on the difference in size of otherwise similar pollen grains. Figure 2 presents drawings of modern pollens which bring out the points just mentioned. Of course, a pollen analyst must know at sight many more types of pollens than those shown in Fig. 2. Some pollen grains are extremely small, and it is, therefore, essential that the analyst has a microscope equipped with a mechanical stage and an eyepiece micrometer. Tabulation is usually made under 640× magnification. Thus equipped, the analyst is now ready to study the sediments and their microscopic content to construct again the characteristics of phanton forests of the past. One feature becomes more and more accentuated as wider geographical areas are being included in pollen analysis data, different regions are characterized by distinct patterns of forest succession, so that one can easily name the locality from a given pollen profile. Suppose we begin in the southern limits of Early Wisconsin glaciation in Indiana and move northward to northern Michigan. In Indiana we have a rather wide belt of Early Wisconsin as well as Late Wisconsin territory, and so the likenesses and differences in forest succession in these two locations are well accentuated. (Compare figure of Bacons Swamp with that of Shipshewana Lake.) Physiographically there is a striking difference between areas of Early and of Late Wisconsin glaciation in Indiana. Not a single lake remains in Early Wisconsin areas, while Late Wisconsin territory is known as Indiana's lakes area. As one analyzes the vegetational changes in these two regions there enters a somewhat puzzling question. One would expect that between the close of Early Wisconsin and beginning of Late Wisconsin glaciation southern tree genera (oak, hickory) should have replaced spruce, and with advance of Late Wisconsin ice sheets spruce should have again replaced the southern species. Such a condition has, however, never been encountered in areas of Early Wisconsin glaciation. The only difference between pollen profiles from these two types of locations is that bogs from Early Wisconsin territory record greater number of foot-levels of spruce dominance, without any intermediate decline or replacement. This can only mean that a rigorous climate persisted along the ice border during the interglacial period, and pre-

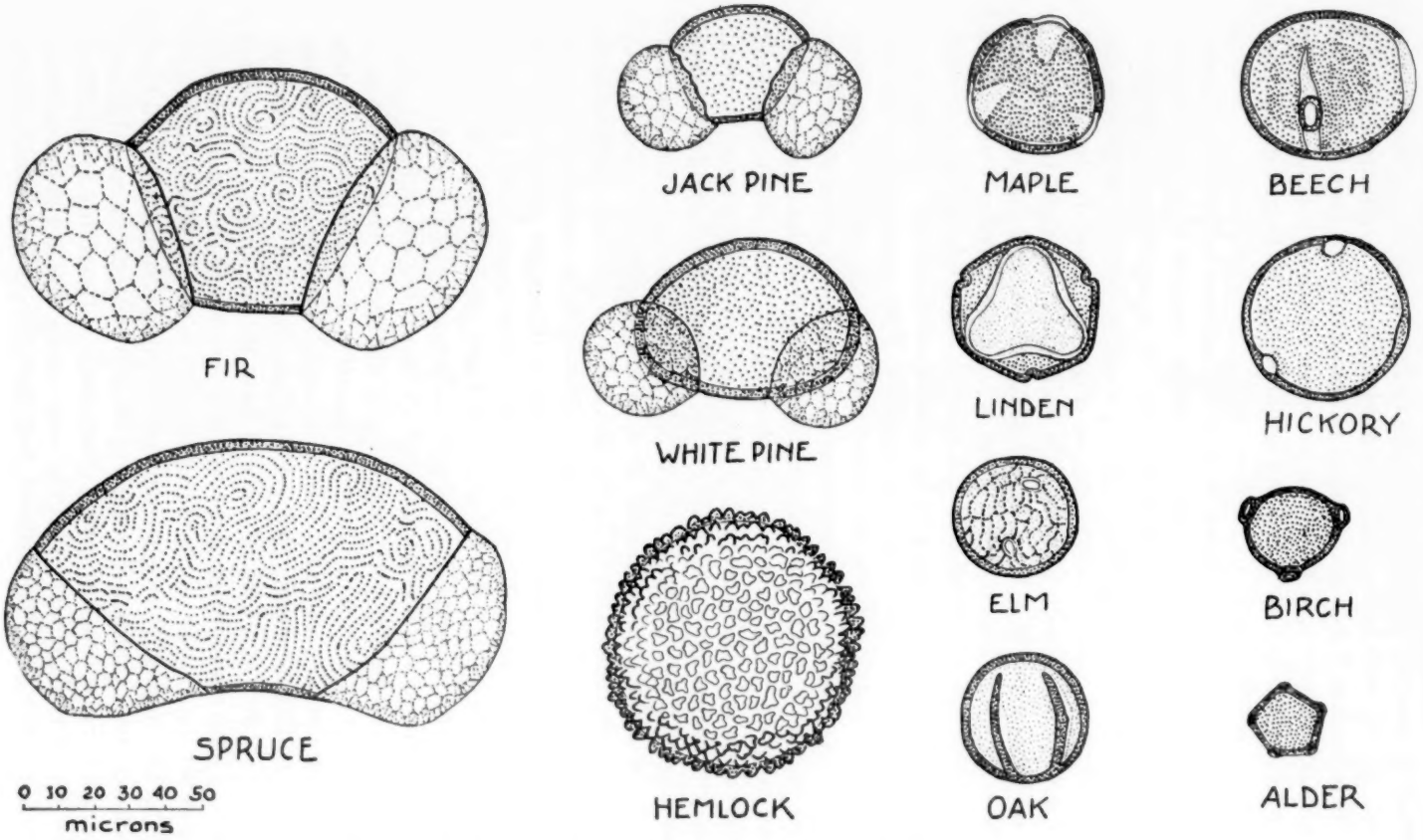

FIG. 2. Types of pollen grains most frequently found in lake and bog sediments.

vented invasion by broadleaved genera like oaks and hickories.

A second significant feature is that in Early Wisconsin areas pine never became a controlling genus. Importance of pine in the forest composition increased progressively (as shown by foot-levels where it shows greatest pollen abundance) as one progresses from central Indiana northward, until in northern Michigan and Wisconsin two patterns of forest types developed. In sandy areas the change was from spruce to pine, and the latter had persisted to the time when civilized man made his appearance, while in areas of better loam and clay soils importance of pines was markedly reduced by hemlock, yellow birch, beech and maple (at least in some locations). These two forest types were very familiar to the early settlers in these states. The pollen preserved in the lake and bog sediments also constitute the only available record to show how from a universal pine climax, which was found on all types of soil, northern hardwoods replaced pine on better soils during most recent postglacial times.

Pollen studies from Michigan, likewise, clearly show that hemlock was never very abundant in the forests south of Clare and Midland counties on the east and Oceana County on the west. Hemlock never exceeded five per cent in central Lower Michigan and rarely reached more than one per cent in scattered representation in Indiana bogs.

Canadian spruce was uniformly the most important species during early forest invasion from central Indiana northward into the lakes States. In states bordering on the Atlantic spruce and pine constituted the early forest composition.

Geographical location of the bogs represented by pollen profiles in Fig. 1 is as follows: Bacons Swamp, Indianapolis; Shipshewana, near the Indiana-Michigan state line; Third Sister Lake, Ann Arbor, Michigan; Austin Bog, 35 miles west of Saginaw, Michigan; Douglas Lake, near the upper tip of the Lower Peninsula of Michigan. Pollen profiles are read from the lowest level in a bog upward. Each horizontal line represents a foot-level and 100 per cent of pollen counted at a given foot-level. Note that early history of forests was very uniformly spruce, however, in areas of Early Wisconsin (Bacons Swamp) this genus controlled during more foot-levels than in bogs located in Late Wisconsin territory. Importance of pine increased tremendously as one moves northward from Indianapolis, while oak and hickory decrease in importance. All of these features are graphically shown in Fig. 1.

Pollen analysis has a fascination which is difficult to express, for in these tiny specks of pollen dust are reflected the great silent centuries where Nature worked uninfluenced by man and graciously entrusted its tiny memoirs to the sparkling lakes of yesterday. They filed them neatly sheet on sheet as each year brought springtime with its clouds

of pollen dust. One thrills at the first record of a new genus, but somehow feels a tinge of sadness as ever now and then a great vegetation bows out with steadily declining pollen records in ever-deepening layers of the dark-brown peat. And then the curtain call! One lonely pollen grain, the last! How did the last tree die? Was it a stately monarch of his race, or was it gnarled and twisted as hands of old men weary of the years of toil? Such thoughts creep in as ever new pollen profiles develop into graphs, the microsketches of the throbbing life of phantom forests of the past.

PHYSICS SECTION

1947 meeting of C.A.S. & M.T.

The meeting of the physics section was called to order by the chairman, Ralph W. Lefler of Purdue University.

In speaking of "Physics of the 20th Century," Dr. Lark-Horowitz of Purdue University, maintained that our physics books could have been written in 1890 except for a few pages that deal with modern physics. It was this new material that was used in the presentation and illustration of the usual subject matter.

In uranium fission the bursting of an atom that marked its track upon a plate was used to illustrate Newton's 3rd law of motion. The experiments of optics dealing with reflection, refraction and polarization were performed with electromagnetic waves as used in radar. Refraction experiments which proved the wave theory were demonstrated. Photo-electric effects, which cannot be explained by the wave theory, were produced by discharging an electroscope with ultraviolet. Demonstrations with radioactive substances were shown with activated materials now available from Oak Ridge.

It is the contention of Dr. Lark-Horowitz that discussions of physics can be enlarged and enlivened by drawing on the materials of modern physics for illustrations.

Mr. G. P. Cahoon, Department of Education, Ohio State University distributed copies of "Selected References for High School Physics." This was a list of 75 books carefully selected primarily for student use in classroom, laboratory and outside work rather than for teacher reference. The hope was expressed by many that the section would find it possible to bring out a "yearly model" of such a list.

"A Series of Demonstrations Useful in High School Physics" was presented by Robert Grubbs of Shortridge High School, Indianapolis. He demonstrated a magnetic method of picking up overtones of vibrating strings that could be used with a loud speaker or oscilloscope. A tin can calorimeter, a home made stroboscope, and an electromagnetic release for measuring falling bodies were included in his list of demonstrations.

A manuscript of Dr. Lark-Horowitz's address, the list of selected books compiled by Mr. Cahoon and a record of the demonstrations by Mr. Grubbs will be made available for publication in this journal.

At the business meeting the following officers were elected:

Chairman: Frank H. Uveling; Schurz High School, Chicago
Vice-chairman: J. Leo Walton; Western High School, Detroit
Secretary: J. S. Richardson, Ohio State University, Columbus.

J. LEO WALTON, *Secretary*

A PLAN FOR THE IN-SERVICE TRAINING OF TEACHERS IN THE ELEMENTARY SCHOOLS

HERSCHEL E. GRIME
Cleveland Public Schools, Cleveland, Ohio

Most of the teachers in the elementary schools of our country are required to teach all the subjects in the elementary school curriculum. For this reason it has been necessary for them to secure a broad general training covering many subjects rather than an intensive training in one or two subjects. Furthermore, since they are interested in so many different areas of learning, it is very difficult for them to find the time required to keep abreast of all the changes that take place in the philosophy underlying the teaching of each of these subjects.

Since most teachers in the elementary school have not had a great deal of training in the field of arithmetic, many of them need help in interpreting the philosophy of the teaching of the subject. They need help, also, in putting this philosophy into practice. They must be encouraged to develop alertness in recognizing and skill in using effectively the number situations that arise in the daily activities of the classroom. Many need help in planning projects or units of work which require the pupil to do quantitative thinking or which provide motivation for the drill necessary for mastery of the skills.

For several years, the supervisors in the Division of Mathematics of the Cleveland Public Schools, assisted by the principal and teachers at the Arithmetic Curriculum Center, have carried out a carefully planned program of in-service training for teachers in the primary division. The outstanding features of the program will be described in this paper.

THE ARITHMETIC CURRICULUM CENTER

A school system, such as that of Cleveland, is too large for wholesale experimentation, yet, fairness to the children of the city demands the continuous improvement of the curriculum. To facilitate the appraisal of new ideas and new methods of teaching, and to carry on curricular experimentation and revision, Cleveland's school leaders, in 1928, established nine elementary school Curriculum Centers. Each of these centers is devoted to the consideration of one curricular subject and the contributions its study can make to the education of the children of the city.

In effect, the centers serve as experimental laboratories that inquire into the most effective ways of teaching various school subjects. The results of the experimentation are passed on to all the elementary schools of the city, as soon as they have been carefully

checked. In this way, every teacher and every child in the city benefits from the work done at the Center.

At present, Almira School serves the city as the Arithmetic Curriculum Center. At this school, the teachers and the principal, working with the supervisor of arithmetic and other members of the school staff, experiment informally with various procedures and techniques. They try out and evaluate different methods of teaching the various topics in arithmetic. They study the needs and the interests of children of various ability levels and develop effective teaching units to meet these interests and needs. Visual aids and devices, supplementary books and workbooks are evaluated at the Curriculum Center, and either rejected or recommended to other schools in the city on the basis of the evaluation.

One of the major contributions of the Curriculum Center is the opportunity it affords for elementary teachers of the city to visit the Center and observe children being taught by teachers who have a special interest in arithmetic and who are able to teach the subject well. In addition, teachers, after spending several years at the Center, may be transferred to other schools where, because of their interest in arithmetic and their experience at the Center, they are in a position to help other teachers improve their ability in teaching this subject. Over a period of years, the work of the Curriculum Center has influenced and improved the teaching of practically every teacher in the elementary schools of Cleveland.

Demonstration Lessons by Radio

For a number of years, one 15-minute lesson in arithmetic has been broadcast each week over the Cleveland Public Schools FM Radio Station WBOE. The lessons, which are of an informal nature, cover various phases of the arithmetic program. The children and the classroom teacher take an active part in each of them. The lessons present a concrete type of arithmetic intended to develop insight and understanding. The concepts and skills taught are those that can be used by children in their everyday experiences. They deal with such topics as using the calendar, making change, shopping for Mother, the Community Fund and planning a class party.

Some of the lessons are designed to teach the fundamental processes of arithmetic, such as the meaning of multiplication, or borrowing in subtraction. All processes are taught by means of concrete objects, using groups of children, coins, bundles of tickets and the like. The practice or drill for each process is discussed in the Teacher's Guide, under "Follow Up." The actual drill is not given in the radio lessons. The main purpose of the lessons is to make arithmetic meaningful and interesting to the children.

The lessons have been prepared and broadcast by teachers who are specialists in the teaching of arithmetic. These teachers have been allowed sufficient time to prepare the lessons carefully, so that each lesson demonstrates a good way of teaching a particular topic. The techniques and methods used with the lessons are those which have proven successful under varied classroom conditions. The visual aids and devices constructed for use in the radio lesson may be used by the teacher in her daily classroom work throughout the year.

While the radio should not, in any sense, be considered a substitute for the functions of the supervisor of arithmetic in visiting a class at work, it does serve as a means by which over 100 teachers have been reached each semester and have been contacted once a week. Every one of these teachers has participated in carefully-planned lessons, intended to develop concepts and meanings. Through this active participation, the teachers of the city have learned new techniques and procedures for putting meaning into the arithmetic they teach.

A Course of Study in Arithmetic

In the fall of 1947, a Course of Study in Arithmetic for the primary division was published. The materials presented in this course of study are the result of careful study and experimentation over a period of many years. Practically every primary teacher and principal in the elementary schools of Cleveland contributed suggestions or participated in some phase of the study, planning and experimentation that was involved in its development.

This course of study states in simple language the philosophy underlying the teaching of arithmetic in the primary division. It is intended as a guide and a source of help in making arithmetic vital and meaningful to the primary child. Each of the objectives of the course is listed with many suggested procedures for teaching each of them. Liberal use has been made of illustrations to clarify procedures where necessary.

One section is devoted to units of work or projects that can be used to make arithmetic meaningful and to show how it can be used in everyday classroom activities. Another section is devoted to games and devices through which the child is led to discover the meaning of number facts and relations, or which may be used for practice.

For the purpose of evaluation, a series of tests, based on the objectives of the course of study, has been developed. These tests are used by the teachers to help determine when a particular pupil has mastered a group of objectives and is ready to go on to more advanced work.

It is not enough to formulate a philosophy and to write a course of study based on this philosophy. A course of study, no matter how

carefully it has been prepared, is of little value if it is not actually used by the teachers for whom it is intended. To acquaint teachers with the arithmetic course of study and to offer suggestions as to how it might be used, a series of discussion meetings was planned. Every teacher in the primary division of the Cleveland schools was required to attend one meeting. So that teachers might derive the most value from the meetings, the number in attendance at any one of them was limited to thirty. The supervisor of arithmetic discussed briefly the plan of organization of the course of study and ways in which it might be used. Opportunity was then given the teachers to ask questions and to express their opinions concerning the contents of the course and its use. As a result of these meetings, the course of study was put into use in all the elementary schools of the city in a comparatively short period of time.

An Arithmetic Clinic for Teachers

In 1945 and again in 1946, a meeting of all teachers in the primary division was held at the Arithmetic Curriculum Center. At these meetings, teachers from the Center discussed various phases of the arithmetic program and gave demonstrations of procedures that had proven successful. Everyone agreed that the meetings were very much worthwhile; however, in such a limited amount of time it was impossible to cover more than a few of the topics taught to primary children. To overcome this weakness, it was decided, in the fall of 1947, to hold a series of meetings rather than only one.

During the present school year, meetings have been held on Saturday mornings. Although attendance is entirely optional and no credit is granted, approximately 500 teachers took advantage of this opportunity to improve their ability in the teaching of arithmetic. Teachers interested in the kindergarten and first year primary met as a group and those interested in the work of the upper primary years met as another group. Each group met for an hour and a half on each of four successive Saturdays. So that there would be an opportunity for asking questions and for taking part in the discussion, the number in a group was limited to 25.

The person in charge of the group, assisted by teachers from the Curriculum Center, discussed different phases of the arithmetic program and demonstrated good teaching methods. Emphasis was placed on the use of concrete materials to give meaning to the arithmetic taught in the first years of school. Teachers were shown how to teach the meaning of numbers, using the abacus, coins, tickets and bundles of tickets. They were shown how to give meaning to the process of carrying in addition by the use of dimes and pennies, and bundles of tickets. They learned improved ways of conducting an activity or

project such as keeping attendance, conducting a Valentine Sale, and collecting and keeping a record of money for the Red Cross.

Teachers, principals and members of the school staff are agreed that the plans for in-service training of teachers, discussed in this paper, have resulted in a distinct improvement in the arithmetic being taught in the Cleveland schools. Plans have already been made for continuing this program for primary teachers and for extending it to include the same kinds of training for teachers in the upper elementary division during the next school year.

TECHNICAL BUREAU TO BE NEW FEATURE AT NATIONAL CHEMICAL EXPOSITION

"The newly created 'Technical Bureau' at the National Chemical Exposition, Chicago Coliseum October 12–16, 1948, will be a personal information service available to all who are in attendance at this great international Exposition," says Dr. Clifcorn, chairman of the Exposition Committee, Chicago Section, American Chemical Society.

"The technical bureau will be manned between 3 and 6 P.M. each day by the internationally known Dr. Ward V. Evans, retired chairman of the chemistry department of Northwestern University, now professor of chemistry, Loyola University," says Dr. Clifcorn.

Thousands of specific problems, both on product development and production, are brought to the Exposition. It is intended that the technical bureau personal service should speed up the finding of the solutions to these problems, according to Dr. Clifcorn. "With practically every manufacturing process involving chemistry in some way, this Exposition, with its approximately 200 exhibitors and newly created technical bureau, will again be of inestimable value to all American industry," the chairman stated. "Everyone is urged to come to the Exposition with specific problems."

BRUCELLOSIS ATTACKS MANY VETERINARIANS

A warning that the entire veterinary medical profession is threatened by a disease of animals has been sounded by Dr. Thurman B. Rice, professor of public health at Indiana University.

Dr. Rice reports statistics show that half of the veterinarians engaged in large-animal practice have had brucellosis, known as undulant fever in man.

In the central-west, he estimates that as many as 90% of the veterinarians have the disease or have had it.

Hogs are rated the most dangerous source of infection, but cattle, goats, sheep, horses and occasionally dogs may pass on the disease. The germ enters the human body not only through a skin abrasion or the membrane of the eye but also through normal skin.

Research workers handling infected animals "are nearly sure to get the disease," Dr. Rice warns.

A DEFINITION OF SCIENCE

That portion of accumulative knowledge in which new concepts are continuously developing from experiment and observation and lead to further experimentation and observation.—Conant: *On Understanding Science.*

CHARACTERISTICS OF MATHEMATICS IN THE SHOP

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The basic importance accorded mathematics in the various war training programs has not diminished with the return of industries and personnel to civilian pursuits. In the case of the mathematics inherent in the shop the importance has been enhanced since there are in the shop many ideal applications of formal algebra, geometry, and trigonometry.

Whether the mathematics teacher is teaching shop mathematics or using shop applications in academic courses, familiarity with the characteristics of mathematics used or applicable in the shop is absolutely essential to successful teaching. These characteristics will be discussed under five headings:

1. *Shop Mathematics Is a Part of a Shop Operation.* Suppose, for example, that a housing plate on a certain machine is designed to have seventeen bolt holes equally spaced around a circle. The production drilling of these housings would require a drilling fixture to accurately center and guide the drills. In making this fixture, the machinist would use what is called an indexing (or dividing) head to equally space the seventeen holes in the fixture. The formula (for most heads) for indexing equal spacings is $T=40/N$. The evaluation of this formula is but a part of a shop operation, namely indexing; the operation in this case is but part of another operation, the making of a fixture. The fixture in turn is part of a manufacturing operation, drilling seventeen holes in a plate that is part of a machine. Very likely the machine is but one item of several being manufactured by the company.

The teacher should appreciate, too, that the shop operations of which mathematics is a part are usually expensive operations. In the preceding illustration the fixture represents an investment in material, labor, overhead, and manufacturing equipment before applying the formula $T=40/N$. The investment is increased after the indexing is done as indicated by the evaluation of the formula. If a mathematical error is made and the fixture spoiled not only is the investment so far wasted, new losses are added due to disruptions arising from scheduling the making of a new fixture and the delay in production of drilled housings.

2. *Shop Mathematics Is Functional.* All formal algebra courses present a unit of study devoted to radicals. In this unit the problem of rationalizing fractions within the radical sign is considered. Rational-

izing such expressions occurs in the shop but only functionally and never formally. The formula for computing the depth of stock, d_s, to remove from round shaft stock of diameter D, to form a given width of flat, w, is

$$d_s = \frac{D - \sqrt{D^2 - w^2}}{2}.$$

If a quarter inch flat is to be machined on half inch stock and the work is to 0.001″, the substitution of these data in the formula reduces to

$$d_s = \frac{0.500 - \sqrt{3/16}}{2}.$$

The evaluation of $\sqrt{3/16}$ is accomplished in the shop *not* by extracting the square root of the decimal equivalent (a slow process) but by evaluating $\frac{1}{4}\sqrt{3}$ with the aid of a table of square roots (a speedier process with less chance for error).

The fractions arising in shop calculations are almost exclusively fractions with denominators $2x$ in which x is a positive, whole number. Consequently, rationalization of shop fractions, such as $\sqrt{\frac{7}{8}}$, is done functionally, $\sqrt{14/16}$, without reference to the formal treatment, $\sqrt{a/b} = 1/b\sqrt{ab}$.

3. *Decimal Accuracy Depends on Use of Results.* The formula, rpm = 4(CS)/D permits computing the setting in revolutions per minute of a lathe, grinder, or drill to obtain a given cutting speed, CS, on work of diameter D. Obviously no decimal refinement in computed results is necessary since the machine would be set to the machine speed setting nearest the computed revolutions per minute.

On the other hand, if the formula

$$h_c = \frac{2}{c}\sqrt{s(s-a)(s-b)(s-c)}$$

is being used on an inspection set-up of work being held to tolerances within ten thousandths of an inch, the computations would be carried to five decimal places and rounded off in the last step to 0.0001″.

The decimal accuracy should always be specified and the computations made accordingly.

4. *Correctness Must Be Certain.* The two taskmasters of mathematics in the shop are money and time. Consequently, the mathematics must be correct, and computed as speedily as possible. The "cash value" of mathematics in the shop was pointed out in Heading

1. The contribution of functionality to decreasing computation time and increasing accuracy was noted in Heading 2. The point made in Heading 3 was that the computed result must be in usable accuracy.

The only mathematics that has any value in the shop is usable mathematics. Hence, the mathematics in the shop must be certainly correct.

5. *Mathematics Available in Directly Usable Form.* The time and the cost factors in the shop dictate that all mathematics be in directly usable form. For instance the amount of taper per foot, tpf, on a round shaft is expressed in the formula

$$\text{tpf} = \frac{(D_l - D_s)12}{l_t}.$$

D_l represents the shaft diameter at the large end of the taper, D_s, the diameter at the small end, and l_t, the length of the tapered portion of the shaft. The shop man may have occasion to know D_l in terms of tpf, l_t, D_s, and 12 or D_s, or l_t in terms of the other factors. These transformations of

$$\text{tpf} = \frac{(D_l - D_s)12}{l_t}$$

should be available to him as:

$$D_l = D_s + \frac{(\text{tpf})l_t}{12}$$

$$D_s = D_l - \frac{(\text{tpf})l_t}{12}$$

$$l_t = \frac{(D_l - D_s)12}{\text{tpf}}.$$

These transformations are excellent and legitimate exercises in formal algebra but in the shop the only concern is the formulas for D_l, D_s, and l_t ready for use.

The five characteristics of mathematics in the shop discussed in this paper are the five characteristics that must be observed either in teaching shop mathematics or in introducing shop applications in classes in formal algebra, geometry, and trigonometry.

Napoleon created an empire; Laplace created a consistent mechanical picture of the entire universe.—Infield: *Whom the Gods Love.*

MOTION PICTURES FOR HIGH SCHOOL SCIENCE

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It is common knowledge that motion pictures may provide valuable educational experiences for science courses. This view is further supported by Keeslar[1] who concluded that "there is good evidence that the best instructional films in science, as represented by twenty-four selected films, may teach, or at least are fitted to teach, scientific principles." The understanding of scientific principles as an objective of the teaching of science is supported by the committees which prepared the 31st Yearbook of the NSSE[2] and the 46th Yearbook of the NSSE.[3]

The purpose of this study, therefore, was to select from various motion pictures which are available for rental, those which, in the opinion of the investigators, were the best suited for use in high school science courses.

It was arbitrarily decided to select for each of the categories of general science topics listed by Curtis[4] those films which in the opinion of the investigators best covered the subtopics under each category, presented accurate scientific information, exhibited good photography, and had clear sound reproduction.

From the various science films listed in *Film Guide*,[5] were selected those whose content might contribute to the development of the subtopics listed by Curtis. These films were reviewed, and those which met the criteria previously stated were judged as worthy for presentation in high school science courses.

The following lists include the categories of science topics for which the films were recommended, the title of the film, whether a sound film or a silent film, the time required for presentation, a series of code letters indicating the film publisher, and a brief statement of the film content. Appended to the article are the addresses of the various film publishers.

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[1] Oreon Pierre Keeslar, "Contributions of Instructional Films to the Teaching of High School Science." Doctors dissertation, University of Michigan, 1945. iv+320 pp.

[2] "A Program for Teaching Science," *Thirty-first yearbook of the National Society for the Study of Education, Part I*. Chicago: Distributed by the University of Chicago Press, 1932. xii+369 pp.

[3] "Science Education in American Schools," *Forty-sixth yearbook of the National Society for the Study of Education, Part I*. Chicago: Distributed by the University of Chicago Press, 1947. xii+306 pp.

[4] Francis D. Curtis, *A Synthesis and Evaluation of Subject-Matter Topics in General Science*. Boston: Ginn and Co., 1929. 83 pp.

[5] Dorothy E. Cook and Barbara Borden (comp.), *Educational Film Guide, Annual Edition*, September 1947. New York: H. W. Wilson Co. 548 pp.

AIR

*Atmosphere and Its Circulation** Sd 11 EBF

A two part film, part 1 dealing with the pressure, composition, distribution and weight of air; part 2 dealing with the circulation of air on an ideal globe of smooth surface, and actual wind movements as affected by the earth's rotation.

Atmospheric Pressure Sd 15 EBF

Effects of air pressure on objects in terms of practical applications such as vacuum cleaners, pumps etc. Air pressure variations at various levels on earth's surfaces are illustrated.

Oxygen Sd 11 COR

Surveys properties of oxygen and its compounds and suggests their importance to mankind.

Air in Action Sd 10 COR

Illustrates the effect of moving air on bodies such as airplane foils, and shows the effects produced by moving bodies in air. Animation and simple experiments illustrate Bournelli's principle.

ASTRONOMY

The Solar Family Sd 10 EBF

Illustrates the evolution of the solar system according to planetismal hypothesis. Explains the real and apparent movements of planets, comets and satellites.

Earth in Motion Sd 10 EBF

Proof of the earth as a sphere is presented using Foucault's pendulum and star trails. Proof of revolution is presented by the position of the earth relative to stars, seasonal changes, and aphelion and perihelion.

Earth and Its Seasons Sd 10 KB

Explains changes of seasons, vernal and autumnal equinoxes, and summer and winter solstices. The angle of the sun's rays in hemisphere is used to illustrate areas of the earth to be heated.

Exploring the Universe Sd 10 EBF

Demonstrates construction of telescopes. Animated drawings are used to show probable changes in the Big Dipper in the next 100,000 years. Illustrates star groups, galaxies and phenomena associated with them. Portrays the expanding universe.

What Makes Night and Day Sd 8 YA

Uses globe and light source to illustrate cause for night and day, and shows why only half of the earth's surface can be illuminated at one time.

BUILDING MATERIALS

Shelter Sd 10 EBF

Depicts the effect of climate and materials on types of shelters man uses, and how man adapts raw materials available for various types of shelters to suit needs, i.e., adobe houses, use of brick, cement and steel in modern structures.

Trees and Homes Sd (cld) 33 W

Shows methods of cutting, transporting and finishing lumber for building purposes. Illustrates conservation policies in order to maintain lumber supplies.

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* The description of the film is read thus: The film *Atmosphere and Its Circulation* was judged to be of value for developing the topic "Air." The film has a sound track, is not a colored film, has running time of eleven minutes, and is published by Encyclopaedia Britannica Films, Inc. (EBF)

Story of Rock Wool Insulation Sd 25 USBM

Dramatized account of need for insulation in order to prevent drafts, and to make homes comfortable. Discusses loss of heat caused by poor insulation.

Manufacture of Pennvernon Window Glass Sd 8 PPG

Illustrates the manufacturing of plate glass from raw material to the finished product.

Asbestos Sd 30 USBM

Shows the mining of asbestos-bearing rock, processes for crushing fibers, shipment, and uses of asbestos for manufacture of household materials.

CLOTHING

Clothing Sd 10 EBF

Shows development of manufacturing processes of textiles from the primitive hand methods to modern mass production. Stresses influence of climate on modes of dress.

Making of Shoes Sd 11 EBF

Shows how shoes are manufactured in modern American factories from leather into the finished product.

Clothing for Children Sd (cld) 11 COR

Discusses styles and types of clothing for young children of various ages with respect to health value and practicability.

CRUST OF THE EARTH

The River Sd 31 USDA

Illustrates the results of stripping the soil of foliage and the resultant floods. Describes the necessity of total river valley control in order to alleviate flood conditions.

Wearing Away of the Land Sd 10 EBF

Shows the decomposition of rocks, formation of caves and sink holes, effects of glaciers, and the work of wind in moving soil.

The Plow that Broke the Plains Sd 35 USDA

A historical study of the results of large-scale farming on the Great Plains from the homesteaders to the present time. Presents the causes for erosion, and resultant depletion of the land.

The Work of Rivers Sd 11 EBF

Illustrates the erosion cycle of water on the surface soil, and by animation the formation of deltas, oxbow lakes, water gaps, and meanders.

The Earth's Rocky Crust Sd 11 EBF

Shows the formation of sedimentary, igneous, and metamorphic rocks using animated diagrams. Presents the formation of soil by weathering of rock.

ELECTRICITY AND MAGNETISM

Electrostatics Sd 10 EBF

Shows the production of static electricity, and of positive and negative charges. The static machine is explained, and the electroscope is used to show the effects of charges. Static electricity in form of lightning is also illustrated.

Principles of Electricity Sd (cld) 20 GE

Illustrates, by means of animation, principles of current flow, magnetism, and magnetic fields. Animated illustrations of the volt, ampere and ohm are given. The film shows the action of electrons within the atom.

The Primary Cell Sd 11 EBF

Demonstrates, by means of animation, the construction and operation of a dry cell. Diagrams of cells connected in series circuits and in parallel circuits are presented. The processes of polarization and depolarization are shown.

Elements of Electric Circuits Sd 11 EBF

Explains electron motions, conductors and insulators. Uses animated drawings to show resistance, rate of flow of current and electromotive force. Ohm's law is explained using illustrations of the ampere, volt, and ohm,

Electrodynamics Sd 10 EBF

Illustrates Galvani's discovery of current electricity. The fundamental principles of current electricity and electromagnetism are explained. A. C. and D. C. generators are illustrated.

ENVIRONMENT

Science and Superstition Sd (cld) 10 COR

Illustrates how students may gather experimental evidence to prove facts and disprove superstitions. Emphasizes the scientific method in problem solving.

How Nature Protects Animals Sd 10 EBF

Shows how animals survive by protective coloration and by other protective devices such as speed, mimicry, armor, odors and hidden homes.

Man Against Microbe Sd 15 MET

Dramatizes the milestone discoveries of Leeuwenhoek, Pasteur, Lister, Koch and Behring in the fight against infectious diseases.

The Story of Dr. Jenner Sd 10 TFC

Dramatizes the efforts of Edward Jenner to pit science against superstition in the battle against smallpox.

FIRE

Fuels and Heat Sd 11 EBF

Depicts the process of combustion by animation, the formation of coal and oil by Nature, and the operation of the internal combustion engine.

Damage Control Sd 46 C

Illustrates how the factors fuel, oxygen, and kindling temperature are necessary for combustion, and how kindling temperature and flash point differ. Shows two methods of extinguishing fires.

Fight That Fire Sd 10 TRANS

Shows the methods of prevention of fire and illustrates the use of fire-fighting equipment.

Fire Sd 10 EBF

Shows the necessity of oxygen, fuel and kindling temperature for combustion. Shows fire hazards in home, and how water and fire extinguishers can extinguish fires.

FOOD

Digestion of Foods Sd 10 EBF

Illustrates the processes of digestion carried out in the mouth, stomach and small intestines, and the action of the various digestive juices on the different kinds of foods. Actual functioning of digestive organs is shown.

Consumption of Foods Sd 11 EBF

Shows the food needs of various peoples in terms of number of calories and types of food nutrients. Suggests possible solutions for problems in world food consumption.

Production of Foods Sd 11 EBF

Deals with the methods of producing plant and animal foods, and the interrelation of production of them. Suggests possible solutions for problems in world food production.

Distribution of Foods Sd 11 EBF

A study of the recent developments of food preservation and of the problems of food transportation. Suggests possible solutions for problems in world food distribution.

Payoff Sd 20 WCTU

Shows the harmful effects of alcholic beverages on the body organs. The social difficulties resulting from drinking are shown in a number of dramatic sequences.

Food and Nutrition Sd 11 EBF

Indicates by animation the carbohydrate, fat, protein, mineral and vitamin requirements of the human body. Explains the absorption of sugar by the bloodstream and its conversion to glycogen in the liver.

Purity Squad Sd 20 TFC

A dramatic presentation of the work of the inspectors of the Food and Drug Administration. Shows how unscrupulous persons sell poisonous drugs to the unsuspecting public.

HEALTH EDUCATION

The Teeth Sd 11 EBF

Shows the development and growth of teeth, the need for careful brushing of teeth, and the work of the dentist in their preservation.

The Care of the Feet Sd 11 EBF

Deals with the structure of the foot, the causes of structural defects and ailments, and suggests remedies. Also shows the way to fit shoes.

Eyes and Their Care Sd 10 EBF

The film illustrates the functioning of the eye, the various defects of the eye and how they may be corrected. Illustrates correct eye hygiene.

Defense Against Invasion Sd 12 OIA

By animation, shows how antibodies are built up in the bloodstream to counteract diseases. Illustrates the values of immunization.

Bacteria Sd 12 EBF

Uses microphotography to show the growth of bacteria in a culture medium. Cocci, spirilla, and bacilli are pictured.

House Fly Sd 10 EBF

Shows the four stages in the life cycle of the house fly. Vividly presents its activity in spreading germs. Suggests methods for eliminating the fly menace.

How the Mosquito Spreads Disease Si 12 BR

Shows the complete life history of the mosquito and the various stages of the life cycle of the malarial plasmodium in the blood stream. Shows how malaria and yellow fever may be prevented by attack on the mosquito.

HEAT

Heat and Its Control Sd 20 USBM

Shows the manufacture and use of rock wool insulation for homes and for industry. Illustrates the transference of heat by conduction, convection and radiation.

Thermodynamics Sd 11 EBF

Treats in an advanced form the phenomena concerned with heat transfer. Shows how heat energy is converted into mechanical energy in internal combustion engines, steam engines and turbines.

Distributing Heat Energy Sd 11 EBF

Presents the various sources of heat energy such as coal, oil, gas, wood and electricity. Demonstrates the principles of heating, combustion, conduction, convection and radiation.

LIGHT

Light Waves and Their Uses Sd 11 EBF

Explains the principles of reflection using plane, convex and concave mirrors. Depicts the refraction of light by lenses, using the human eye as an example.

Behavior of Light Si 15 EBF

An elementary presentation of the phenomena of light illustrating the transmission of, and the formation of, shadows and eclipses. Illustrates the images formed by plane, concave and convex mirrors.

How the Eye Functions Sd 11 KB

Shows by animated drawings the operation of the eye. Shows the functioning of the various parts of the eye in refracting and interpreting light rays.

How Man Made Day Sd (cld) 10 COR

Traces the development of man's use of light, and the advancement of various devices for illumination.

Eyes of Science Si 26 BL

A study of the technology involved in making and shaping glass, and of the processes necessary to convert the glass into lenses and prisms for use in optical instruments.

To Greater Vision Sd 28 BL

Illustrates the manufacture of optical glass and the precision grinding of it for optical instruments and eyewear. Explains the treatment of eyes and use of lenses in correcting eye defects.

Nature of Color Sd (cld) 10 COR

Treats color as the mental interpretation of light waves of different frequencies. Shows the practical application of the principles of color in color photography.

LIVING THINGS

The Living Cell Si 15 EBF

Uses microphotography to show the life activities of single-celled plants and animals. Also depicts the life activities of simple metazoans and of various types of tissues.

Plant Growth Sd 10 EBF

Uses time-lapse photography to show the development of the pea from the seed to the mature plant. Shows the processes of pollination and fertilization by means of photography and animation.

Flowers at Work Sd 10 EBF

Shows by means of animation and time-lapse photography the pollination of the flower by insects and the resultant processes of fertilization. Stresses the function of insects in cross fertilization.

Green Plant Si 15 EBF

Explains how the green plant synthesizes food from carbon dioxide and water

in the presence of sunlight. Illustrates the dependence of animals on green plants for food.

Heritage We Guard Sd 30 USDA

Shows the depletion of wild life resources during the recession of the Western frontier, and the depletion of soil resources by the stripping of the plant life. Presents methods of conserving natural resources.

Beneath our Feet Sd 10 TFC

A survey of some of the insects found in the soil and grass. Illustrates some of the life activities of these insects.

Honey Bee Sd 11 EBF

Depicts the life history and activities of the honey bee. Stresses the community life of the honey bee, and its part in pollination of flowers.

Birds of Prey Sd 11 EBF

Pictures the activities of the common birds of prey such as the owl, the eagle, the hawk and the vulture. Emphasizes their special structures for food-getting.

Animal Life Sd 10 HA

A rapid survey of representatives of the various animal phyla. Emphasizes adaptations of respiration, food getting, locomotion and digestion.

Vanishing Herds Sd 14 USDA

Dramatizes the near extermination of the bison, elk, buffalo and other animals, and shows the efforts of various governmental agencies for their restoration.

MATTER AND ENERGY

Atomic Energy Sd 11 EBF

An elementary presentation of atomic structure and the principles underlying atomic energy. Animated sequences show the release of radiant energy and processes of atomic fission.

Electrons Sd 10 EBF

Depicts by means of animation the conduction of electricity through liquids and gases; and develops the principle that the fundamental unit of all electrical energy is the electron.

Energy and Its Transformation Sd 10 EBF

Shows potential, kinetic, and radiant energy and explains how the various forms of energy are changed into other forms. Develops the principles underlying conservation of energy, and illustrates the concepts of work and power.

Matter and Energy Sd 10 COR

Develops the concept that all material in the universe can be classified as matter, and is affected by energy. Defines the relationships between elements, compounds, and mixtures. Concludes with a brief presentation of atomic energy.

Simple Machines Sd 11 EBF

Shows the basic features of the simple machines, and their applications in complex and compound machines.

STUDY OF INDUSTRY

Horsepower Sd 10 JH

Illustrates the origin of the term "horsepower" and shows the development of horsepower by automobile engines.

Industrial Revolution Sd 11 EBF

Depicts the development of man's use of energy to do his work. Develops the use of energy from the steam engine through the modern Diesel.

New Automobiles Sd 27 AM

Illustrates the various products needed for building automobiles and shows the activities taking place on the assembly line for constructing automobiles.

The Magic of Steam Sd 18 JH

Illustrates by animation and photography the operation of the steam turbine.

Story of Leather Sd 14 Tanners

Traces the development of the manufacture of leather products from the rawhide. Pictures modern techniques of tanning, and of preparing leather for specific purposes.

Tree to Tribune Sd 30 CT

Traces the manufacture of paper from the forest tree to the final newsprint roll. Emphasizes the activities involved in publishing a modern daily newspaper.

Iron Mining and Manufacture Si 15 BFS

Shows the movement of iron ore from open pits through the Great Lakes, to the blast furnace. Depicts the smelting of ores in blast furnaces and the pouring into castings.

SOUND

Sound Waves and Their Sources Sd 11 EBF

Uses animation to illustrate the transmission of sound through the air by wave motion. Explains characteristics of sound such as frequency, amplitude and wave length.

Fundamentals of Acoustics Sd 10 EBF

Illustrates how the ear transforms sound waves into sound. Demonstrates the phenomena of reflection, refraction and reverberation of sound, the velocity of sound, and the range of hearing.

WATER

Water Cycle Sd 10 EBF

Shows the movement of water from the ocean to the sky by evaporation, and its return to the ocean by condensation and precipitation. Shows the formation of clouds, and the formation and falling of rain.

Mysteries of Water Sd 10 KB

Presents the gases making up the water molecule and illustrates the importance of water to life, to power, and to erosion.

Our Water Supply Si (cld) 14 GR

Shows how the water supply originates from rainfall, how it is purified naturally, and later becomes contaminated. Depicts the various processes used in purifying water for the public supply.

Properties of Water Sd 11 COR

The composition of water is illustrated by means of electrolysis. Also shows the effect of pressure on the boiling point. Depicts the solvent action of water, formation of saturated and super-saturated solutions. Illustrates the energy changes when water changes state.

Ground Water Sd 11 EBF

Shows how ground water causes changes in the earth's crust. Explains the phenomena of artesian wells, springs, the water table, geysers, sink holes and hot springs.

Irrigation Farming Sd 11 EBF

Shows how man has made use of arid areas for producing crops by various methods of irrigation.

Every Drop a Safe One Sd 10 NM

Illustrates the various steps taken in a modern purification plant to provide pure water. Shows the importance of an adequate supply of pure water for healthful living.

WEATHER AND CLIMATE

Weather Sd 10 EBF

Shows the instruments used in modern weather forecasting. By animation shows the "polar front" weather theory.

Clouds Sd 11 USWB

Portrays the various types of cloud formations and movements of high- and low-pressure areas across the country. Presents the relationships between types of clouds and types of weather.

Prophet Without Honor Sd 11 TFC

A dramatization of the life of Matthew Maury, founder of the United States Weather Bureau. Pictures his struggle to establish the U. S. Weather Bureau.

APPENDIX

(EBF) Encyclopaedia Britannica Films Inc.
20 N. Wacker Dr.
Chicago 6, Ill.

(COR) Coronet Instructional Films
65 E. South Water St.
Chicago 1, Ill.

(KB) Knowledge Builders
625 Madison Ave.
New York 22, N. Y.

(YA) Young America Films Inc.
18 E. 41st St.
New York 17, N. Y.

(W) Weyerhaeuser Sales Co.
1st National Bank Bldg.
St. Paul 1, Minn.

(USBM) United States Bureau of Mines Experiment Station
4800 Forbes St.
Pittsburgh 13, Pa.

(PPG) Pittsburgh Plate Glass Co.
633 Duquesne Way
Pittsburgh 22, Pa.

(USDA) United States Department of Agriculture
Office of Motion Pictures
Washington, D. C.

(GE) General Electric Co.
Visual Instructions Service
1 River Road
Schenectady, N. Y.

(MET) Metropolitan Insurance Co.
1 Madison Ave.
New York, N. Y.

(TFC) Teaching Film Custodians Inc.
25 West 43rd St.
New York, N. Y.

(C) Castle Films
30 Rockefeller Center
New York, N. Y.

(TRANS) Transfilm Inc.
35 W. 45th St.
New York 19, N. Y.

(WCTU) National WCTU
1730 Chicago Ave.
Evanston, Ill.

(OIA) U. S. Office of Inter-American Affairs
Washington, D. C.

(BR) Bray Studios Inc.
729 5th Avenue
New York 19, N. Y.

(BL) Bausch and Lamb Optical Co.
635 St. Paul St.
Rochester 2, N. Y.

(HA) Harvard Film Service
Graduate School of Education
Lawrence Hall, #4
Cambridge 38, Mass.

(JH) Jam Handy Organization
2900 E. Grand Blvd.
Detroit 11, Mich.

(AM) Automobile Manufacturers Association
320 New Center Bldg.
Detroit 2, Mich.

(TAN)	Tanners Council of America 100 Gold St. New York, N. Y.	(GR)	Greenwich High School Photoplay Club Greenwich, Conn.
(CT)	Chicago Tribune Inc. Tribune Building Chicago, Ill.	(NM)	National Motion Pictures Co. West Main St. Mooresville, Ind.
(BFS)	Bailey Film Service 404 N. Goodwin St. Urbana, Ill.	(USWB)	U. S. Weather Bureau Department of Commerce Washington 25, D. C.

WANTED: BETTER MATHEMATICS INSTRUCTION

ROBERT HUMBERT
R.F.D. #7, Muncie, Indiana

I have just passed a course in differential calculus. If the following suggestions were observed by calculus teachers, they would make the subject simpler and ease the lot of both the professors and their harassed charges.

1. Remember that the student is not a genius. Mathematics professors, the cream of the intellectual crop, seldom realize the gap existing between their minds and those of the students. There is an appreciable time interval between the moment an idea is presented in class and the moment it is understood. If ideas requiring ten seconds for comprehension are presented only five seconds apart, they will go by the student like so many streetcars, passing but never stopping, while he stands alone in the cold. Is there a remedy? Certainly. Instead of illustrating a point by a half-dozen confusing examples, use a single clear example, but go over it step by step, slowly, scorning not to do the most trifling bit of arithmetic, no matter how obvious it seems to you. Some of the class will be bored; others will think you insult their intelligence; *but they will understand the problem,* a rare phenomenon indeed.

2. Don't introduce extraneous material. You may be able to derive Einstein's $e=mc^2$; if so, we salute you, but don't spend class time showing us something we aren't expected to learn. The direct route through calculus is long enough, without any side trips.

3. Show us methods for working problems. Theory is important, but we study calculus in order that we may learn to work the problems, and if a superficial trick will help, show us the trick. A booklet describing techniques for working various types of problems would help.

4. Relinquish the theory of formal discipline. Somewhere in the hoary, ancient past arose the erroneous concept that the harder

a problem is, the better it is for the student. Mathematics teachers through the ages have clung to this fallacy, and have ascribed more medicant properties to it than those extolled by the most lyrical label of a cure-all patent medicine. Many of the operations of calculus are as simple in their fundamental applications as they are powerful; yet students spend most of their time on the difficult but inconsequential problems whose solution depends not upon calculus but upon some obscure notion in algebra or trigonometry. Problem solving is essentially a process of analysis and research. Usually, however, it degenerates into a purely clerical task of searching for assistance from a related problem or for errors in calculation, operations of questionable learning value. Very frequently the student will spend his entire study time on such worthless effort, and will thereby fail to learn the important topics of the lesson.

5. Supply students with a handbook of completely solved problems. Examples given in the text are always too few. If an entire volume of solved problems were provided, the student could refer to it for specific help on particular problems rather than being forced to resort to clumsy efforts at adapting to his purposes examples which do not fit the situation. Such a handbook should use diagrams, graphs and step-by-step description as well as conventional mathematical symbols. It should cite references to several texts, although organized in the same order as the text for the course.

6. Insist that textbook authors write clearly. Mathematicians take pride in concise language; yet their very conciseness is one of the chief difficulties the student encounters in learning calculus. Techniques in particular ought to be described step-by-step, even though they appear homely and seem patently self-evident. Every operation in the solution of each example should be shown; otherwise the student will be discouraged from trying to understand it and will attempt without proper background to solve the assigned problems.

7. Give open-book tests. The text is as much a tool as one's pencil, and when students are deprived of it during examinations, not only is their performance impaired, but comparison between students become less valid due to entrance of the factor of memory. An examination ought to be a stimulating experience in learning, rather than a crushing defeat. They should be frequent enough to enable the student to gage his progress and make corrections before it is too late.

8. Look for opportunities to adapt mathematics to people, rather than ruthlessly adapting people to the authoritarian standards of mathematics. Much that would be useful to the general student is denied him by those who prefer to teach a few students of high ability rather than help many students of moderate ability.

AN APPLICATION OF THE HYPERBOLA

ROBERT A. FERTIG
Burlingame High School, Burlingame, California

To help your students understand what an important part mathematics played in the development of LORAN (the newest aid to Long Range Navigation), have them actually carry out the calculations and constructions suggested in the following paragraphs.

1. The speed of radio waves is roughly 186,000 mi. per sec.
2. Calculate how far a radio wave would advance in one micro-second (10^{-6} sec.).
3. Calculate how far a radio wave would advance in 10 micro-sec.; in 100 micro-sec.; in 1,000 micro-sec.
4. On a blank sheet of large paper, centrally locate M and S exactly 186 mi. apart (scale: 1 mm. = 2 mi.). With M as a center, draw a series of about 20 concentric circles with radii of 18.6 mi., 2×18.6 mi., 3×18.6 mi., etc.
5. Label them respectively 100 micro-sec., 200 micro-sec., 300 micro-sec., etc. If a radio signal is transmitted from the master station M, it can be received 100 micro-sec. later on the 100 micro-sec. circle; it can be received 200 sec. later on the 200 micro-sec. circle, and so on. The picture will now look very much like that which develops when one drops stones at regular intervals of time into a still body of water and a series of concentric, circular wave-fronts spread outward from the center of disturbance.
6. When the master station's signal is received at the slave station S, it triggers that station's transmitter so as to send out a slave signal which progresses in a series of concentric wave-fronts with S as a center. Draw about 15 of these circles with radii of 18.6 mi., 2×18.6 mi., 3×18.6 mi., etc.
7. Label these circles respectively 1,100 micro-sec., 1,200 micro-sec., etc. Why?
8. There are now many points of intersection of the two families of concentric circles. Locate, for example, the two points of intersection of the 1,700 micro-sec. slave circle and the 1,300 micro-sec. master circle. A receiving set located at either of these two points will receive the slave signal 400 micro-sec. after it receives the master signal.
9. Locate at least 16 other points of intersection where the slave signal is received 400 micro-sec. later than the master signal.
10. Draw a smooth curve through these points and label the resulting hyperbola #400. Remember, a hyperbola is the locus of a point which moves such that the difference of its distances from two

fixed points, called foci, is a constant. Here the foci are the points M and S.

11. Draw a smooth curve through all the points which receive the slave impulse signal 500 micro-sec. later than the master signal. Label it #500.
12. In a like manner, draw the entire family of hyperbolas associated with M and S and label them #100, #200, #300, up to #1,900. On a LORAN navigation chart, all this family of hyperbolas would be colored red, for example.
13. A navigator who wishes to determine his position uses a LORAN receiving set and measures the time difference between the receipt of the master signal and the follow-up slave signal. Let us assume that this measurement is 700 micro-sec. He immediately knows that he is somewhere on hyperbola #700 (red) on his LORAN navigation chart and refers to this curve as his "line of position."
14. He then tunes in on another master and slave pair and finds that the time difference between their signals is, for example, 1,200 micro-sec. He knows that he is somewhere on hyperbola #1,200 of the family associated with this pair of stations and shown on his chart as a series of green hyperbolas.
15. The crossing of these two "lines of position" (#700 red and #1,200 green) determines, for the navigator, his "fix," or exact position.
16. As a further check, he can tune in still a third pair of master and slave stations. These are associated with a brown family of hyperbolas on his chart.
17. In practice, master and slave pairs are located at convenient points between 200 to 400 miles apart. Their signals may be interpreted at distances up to about 1,000 miles. A navigator may obtain his "fix" in about two minutes, even though he may have to interpolate.
18. The LORAN method should not be confused with the radio-direction system with which it has little in common.

A NEW BALLISTICS CAR

Designed by the W. M. Welch Scientific Company this car makes a striking demonstration. The apparatus comprises a car with cone-bearing wheels and a cylinder with a spring-activated plunger for shooting a one inch steel ball into the air. A pin with a cord attached to its acts as a trigger. When the ball is in place and the spring is cocked, the car may be pushed forward and as it comes to the end of the string, the trigger is pulled and the ball shoots into the air and is caught by the freely-rolling car. Two compressions of the spring are provided. It sells at $15.00.

SOME BROADER EDUCATIONAL ASPECTS OF PHYSICS PROBLEM SOLVING

SHERWOOD C. BAIN
Knoxville, Tennessee

Modern educational emphasis is upon "problem solving" with a range covering every type of problematic situation, from the mathematical textbook, the physics and chemistry textbook, through problems of personal difficulty, of social maladjustment, and economic difficulty. Education is to assist in encouraging a problem-solving attitude, and to teach methods where possible. Physics is par excellence a field in which one learns problem-solving techniques adaptable in many realms of experience by correlation of data, and observing their relation to principles and to useful applications. Teaching to solve problems always involves teaching for the purpose of arriving at solutions of a definite nature, and as a method this differentiates it from merely informing, moulding, indoctrinating, etc.

Brownell points out that all learning is not problem solving.[1] The problematic situation in physics may be either a puzzle merely (which the learner has no means of escaping or solving, or in which he may recognize vaguely where to work though he does not know what to do), or it may be (should be) a real problem, the nature of which the learner is able to understand by reason of his original nature, previous learning, or organization of the task in the present, but for which at the time he knows no direct means of satisfaction. The subject should experience perplexity but not utter confusion. In physics the problem may be to work out a solution, or it may be to mentally construct a new concept, based on the organization of familiar percepts or concepts.

Brownell points out also[2] that problems set should "mean" something to the subject, or "at least envisage the learning task as it is most probably envisaged by the subject." Again "a second change in educational method is the tendency to concentrate research interest, not merely on successes and errors, but on the way in which the *subject* proceeds to attack and solve his problem." Also, "the extent of educational research on problem solving has been confined chiefly to seventy-two published experimental studies on problem solving in arithmetic." A physics teacher will readily recognize that the type of these arithmetic studies has little to do with the over-all type of physics problem-solving situation, except incidentally, and moreover has to date produced apparently little advantage to application in physics. Again, Brownell observes that problem-solving behavior

[1] W. A. Brownell, *41st Yearbook*, National Society for the Study of Education, Bloomington, Ill.
[2] *Ibid.*

is not attributable to the activity of some special faculty or department of mind, "habits do not retire to some convenient distance while some new and mysterious entities direct behavior." Thus, problem solving operates through general principles involved in all behavior phenomena, and all learning behavior.

Brownell further characterizes problem-solving behavior as being *directed* behavior, involving an initial direction, or "set" or goal, also involving "the effect of the subject's successive formulations of the problem itself." Another aspect of problem-solving behavior concerns "trial and error" ***versus*** insight; "insight" has to do with discovery of the correct response, through processes of correction and degrees of approximation, and "organization of behavior appropriate to the organism's goal." An example of failure to gain "insight" is to "master a series of procedures without grasping their rationale, such as learning the steps in working arithmetical (or physics!) exercises without understanding their mathematical ***relations***"; i.e., learning patterned processes apart from flexible functional thinking in applications. Problem-solving behavior, then, in the present analysis, involves direction (set, purpose, goal), successive formulations of the problem itself, and something akin to insight, commonly known as plain understanding of implications, relationships, and ends sought.

The above aspects of problem-solving behavior are easily recognized as concerned with the specific situations met in physics problems in the classroom. In the building up of problem-solving ability, one should become accustomed to definitely formulating a goal, with perhaps successive reformulations of the goal itself, and this with expectation of increasing understanding or insight. The high school physics course is adapted to contribute to such a purpose, in that elementary mathematical techniques and concepts in mechanics carry over into sound, electricity, light, heat, etc.; one learns methods of orderly solution of problems.

What is the *nature* of the goal or direction toward which problem-solving behavior in physics tends? Of course there are the "answers" to get; but there is more. Broader aspects involve further undetermined practical applications in after-school experience, in out-of-school areas. The sensing of a problem involves tensions, due to incomplete knowledge, incomplete understanding of complex situations; this tension motivates to solution; and these facts reveal that an underlying problematic goal or direction is characterized by its being of a completed, integrated contextual nature when the problem is solved; and the solution is felt to be arrived at when a *whole* situation is resolved and "proven." This for teaching purposes, sets the necessity in physics of delineating a *whole* situation of some sort, many parts of which are tangible already, but some parts of which

are "missing," or as yet (apparently), unrelated. Completion of the whole, or solution of the problem in broader implications, involves finding missing parts or relationships between known parts. Often concepts at first obscure become apparent when seen in the light of a whole context into which they fit; facts and laws which are essential, lose their obscurity when seen in the light of some whole context of which they are a part, and then have "meaning," are "understood." Often a teacher (most of us have had the experience) will in his examination cover in his questions a summary of a territory as a whole, which will be a survey of the whole: to find in grading his papers that teaching success might have been greater if the summarization had been presented first, in order to give the whole context as a problematic frame of reference in the original introduction of the field. For work-sheet purposes, sentences with blanks to be filled, should have the "missing" words selected which are needed to complete the whole idea representing a complete context, most of whose parts are contained in the portions of the sentence present; such sentences are then of truly problematic nature.

To summarize: Problems in normal experience are set in broad context, missing elements of which cause the problem to be "set." The direction of the problem is thus defined or set as an incompleted whole context of some sort, then the solution becomes a matter of searching for an unknown factor or factors related to the whole situation, implied in it; while trial and error, re-formulation, proof, using innate or acquired capacities, are involved. These are suggested as some of the broader aspects of problem solving in general, which also apply to the physics problem-solving technique in particular. And conversely, the physics problematical set-up is a rich field for actual experience in orderly techniques of problem solving usable in wider ranges of life beyond the confines of the classroom, or of the field of physics itself.

PROFESSOR REEVE RETIRES

Around 200 former students and colleagues of Professor William D. Reeve, retiring head of the mathematics department at Teachers College, Columbia University, gathered for a testimonial dinner in his honor last night at the Men's Faculty Club (117th Street and Morningside Drive).

It was announced at the dinner that the David Eugene Smith Mathematics Club, which sponsored the testimonial, is accumulating money to set up a William David Reeve Scholarship in the Teaching of Mathematics. The Scholarship will be awarded annually to doctoral students, and approximately $1,500 of a $5,000 goal has been contributed to the fund to date.

A member of the department since 1923, Dr. Reeve is also the long-time editor of THE MATHEMATICS TEACHER. Previous to his affiliation with Teachers College, he was connected with the University of Chicago and the University of Minnesota. His retirement is effective in the fall.

PUTTING MEANING INTO GEOMETRIC CONCEPTS

JOHN J. KINSELLA
Ohio State University, Columbus, Ohio
AND
WALTER H. CARNAHAN
Mathematics Editor, D. C. Heath and Company, Boston, Massachusetts

Experienced teachers of high school mathematics know that a large percentage of students who can readily recite, "The area of a rectangle is equal to the product of its base and altitude," are unable to give a satisfactory answer to the question, "What do you mean by area?" These students can write the rule or formula, but soon reveal that the meaning of the stated relationship has escaped them.

These same teachers could furnish many other illustrations of this kind of verbal learning, from arithmetic as well as from algebra and geometry. The meaning of a fraction would not be found among the intellectual possessions of a considerable part of the student group, although computational skill with the "broken numbers" might be fairly well developed. Many pupils who could readily cancel and transpose would register blank looks if asked about the balance idea or the operation of inverse relationships. Many who could recite the proof of the proposition about three or more parallels intercepting equal segments on one transversal would be unaware of the reasons for using the particular sequence of statements in the argument. In brief, successful performance would be found to be no guarantee of the attainment of understandings or meanings. Facile recitations, correct answers, and high grades on examinations can hardly be accepted as evidence that the intellect of the learner is being given vigorous exercise.

Leaders in mathematical education and large numbers of good teachers have been battling this separation of doing and thinking for at least fifty years. In 1910 J. W. A. Young felt that "Ten pages of mathematics understood are better than a hundred memorized and not understood."[1] In 1911 J. W. Young said that "The mere memorizing of a demonstration in geometry has about the same educational value as the memorizing of a page from the city directory."[2] In 1928 Schultze observed: "The absurdity of making the memory the chief standard for measuring a student's ability cannot be overemphasized. Which is more useful to a person in life, the knowledge of a great many facts, or mental power? the ability to repeat other people's thoughts, or the ability to think for himself?"[3] During the past ten years a meaning theory for the teaching of arithmetic has been pushed forward vigorously by Brownell and others. In fact, two of the Year-

books of the National Council of Teachers of Mathematics and several arithmetic texts in recent years have been strongly influenced by the meaning emphasis.[4] In the field of algebra, Everett as early as 1928 wrote: "This again points to the conclusion that the element of interpretation of meahings is of as great importance as manipulative ability, and it further indicates that the ability to perform an operation demanding manipulative skill is slight evidence that the performance is necessarily attended by a sense of its significance."[5]

Although few teachers object to the proposition that intelligence must play a prominent part in the acquisition of educational products if they are to be used intelligently, there have been occasional criticisms of the emphasis on understanding and meaning.

(1) Progress in many parts of mathematics depends on the attainment of a certain degree of skill and facility. Constant attention to the "why" slows the acquisition of the skill and forces the learner to defend everything he does by some kind of rationalization. For example, something (but not much) could be said for requiring pupils to quote axioms and laws for every step they take in solving an equation. The best compromise seems to be to use whatever procedures are useful for making the initial learning meaningful and then to renew periodically, not continuously, the rationale of the process learned.

(2) Children are sometimes expected to attain a degree of understanding beyond their mental maturity. Mathematics is sometimes made more theoretical than the needs of understanding, retention, and probable future use demand. For example, it seems neither feasible nor desirable at the ninth grade level to develop algebra on the basis of a long discussion of undefined terms, definitions, assumptions, and theorems as is done in the college course often called "higher algebra," or in the demonstrative geometry of the tenth or eleventh grade. The required power of abstraction is not yet developed except possibly in the case of the upper one per cent.

(3) Mathematical insight cannot guarantee the meaningfulness of mathematical ideas and operations in the world of things outside of mathematics.[6] This implies that new mathematical concepts, operations, and relationships must often be based upon personal experiences with the world of objects and ideas already in possession of the learner. It means also that after these mathematical principles have been mastered they should be applied to problems and situations outside the field of mathematics itself.

Area Concepts and Relationships

Let us now return to our hypothetical students who did not know what was meant by area. How can they learn this meaning? One

method is for them to take a handful of gummed paper squares each of unit area and a rectangular sheet of paper and lick and stick until the paper is covered. Then, let them count the squares to find the area. Another method is for them to draw a rectangle on graph paper, shade the squares and count them. A third method is to have the students divide a rectangular sheet of paper into squares, cut out the squares with scissors and count the squares as before. Performing these operations, not once but often, certainly pays dividends in learning what area means.

What are the features of these activities that lead us to believe in their effectiveness? Van Engen gives them as follows: "What are the elements of an experience that provide the essence of meaning? They are the overt acts that a child has performed, or has observed someone else perform, while working with a number of objects directly presented to the senses. . . . These operational meanings become established by first watching someone else—the teacher, for example —perform the operation with the accompanying words that mean the operation."[7]

Does Van Engen imply that these "overt acts" must be performed every time the child deals with area? No. He says, "As the child's grasp of the meaning becomes firmer, he can set aside the objects and visualize the object. . . . The child is now ready to establish meanings of a higher order based on the symbolization of these primary meanings."[8] For example, it is fairly easy for the child to obtain a method for getting the area of a rectangle 40×50 after he understands the area of a rectangle 4×5.

What happens when the rectangle's dimensions are in terms of fractions or decimals or very large numbers? Again we quote Van Engen: "When the operations and the symbols are firmly united in the minds of the pupil, then the teacher can generalize the symbols by edging over into the area in which it is inconvenient or even impossible to perform the operation."[9] Van Engen's procedures can be summarized as direct experience followed by visualization which in turn is followed by abstraction. However, in the case of the specific problem here introduced, that is, rationalizing the area of a rectangle whose dimensions are fractional, the geometric interpretation is very simple and enlightening.

How can we proceed in meaningful sequence from the area of a rectangle to other areas? Have the students draw a rectangle and one of its diagonals. Let them cut out the two right triangles and superpose one on the other. They will readily see that the area of right triangle equals one half the rectangle having the same base and altitude.

It is natural to consider next the area of a general or scalene triangle. In Figure 1 a rectangle has been built around scalene triangle ABC. Altitude BD has been drawn. It is easy to see that each right triangle formed is half of a rectangle and that the whole triangle ABC is one

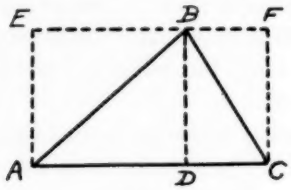

FIG. 1

half the rectangle $ACFE$ having the same base and altitude. Of course the triangles AEB and BCF can be cut off, rotated, and made to cover ABC. Again, the triangle is one half of the rectangle. The same procedures can be used in obtaining the areas of the parallelogram, the trapezoid, and other polygons. Instead of many separate formulas to memorize, one method, dissection, gives insight into all rectilinear areas. One organizing principle serves to unify learning experiences and give them meaning. Katona found that such organizing principles yielded learning that was comparatively permanent and widely applied.[10]

How can the meaning of π be made clear? Have the students measure with a tape the distance around wheels of different sizes and also the maximum distance across them. The quotients of the circumferences by the diameters yield approximations to π. Another procedure is to chalk a mark on a wheel, roll the wheel along a straight line for one revolution, measure the distance obtained and divide by the wheel's diameter. If wheels are not available, use other circular objects.

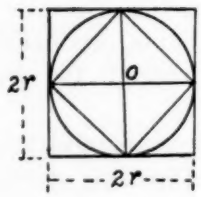

FIG. 2

How can the formula for the area of a circle be made meaningful? In Figure 2 it can be shown quite easily by using the triangles that

the area of the circle is more than $2r^2$ but less than $4r^2$. Some students will guess that it is $3r^2$. What can be done to make them obtain a more accurate result?

It is not a long step from a discussion of Figure 2 to an understanding of the device shown in Figure 3 which is a modification of the device suggested by Katherine Young on page 373 of the *18th Yearbook of the National Council of Teachers of Mathematics*.[11] We shall omit a

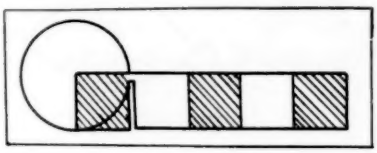

FIG. 3

description of the details of the device. Fill the circle part with shot. Let the shot run out into the squares below the circle. It will be found that the shot will completely fill three squares and one seventh of the top square. Hence, the area of the circle is seen to be approximately equal to $3\frac{1}{7}$ times a square on the radius.

Areas of cylinders, cones, and spheres

Have the students wrap a piece of paper around an oatmeal box, or tin can, or pipe. Have them unroll the paper to make a rectangle

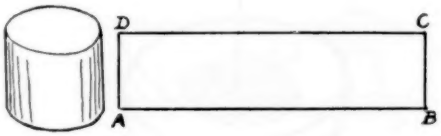

FIG. 4

whose area obviously is the lateral area of the cylinder. The base of the rectangle is the circumference of the base of the cylinder and its altitude equals the altitude of the cylinder. Hence, the lateral area of the cylinder equals the product of these two measurements. This development is enlightening, not only in the junior high school, but also in plane and solid geometry classes.

Wrap a piece of paper around a cone. Unroll it and a circular sector is obtained as in Figure 5. In junior high school classes it may be necessary to lead up to an intuitive acceptance of the sector as a special kind of triangle. By analogy to the triangle, the area of the

sector equals one half the product of the base, which is the circumference of the base of the cone times the altitude which can be taken to be the slant height of the cone, since the slant height is the distance from the vertex C to the base at D. Thus, it is intuitively shown that the lateral area of a cone equals one half the circumference of its base

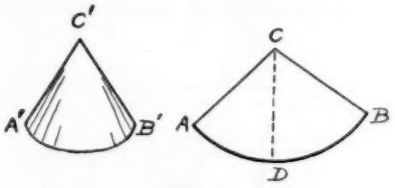

FIG. 5

times its slant height. In plane or solid geometry classes the lateral of a cone can be obtained by determining the area of the sector by the relationship "The area of the sector is to the area of the circle having the slant height as radius as arc AB, the circumference of the cone's base, is to the circumference of the circle having the slant height as radius."

Area of the sphere. Take half of a croquet ball or any other wooden or solid rubber ball. Drive a nail at the center A of the cross-sectional great circle (Figure 6) and another at P at the vertex of the hemisphere. Now take a piece of strong cord, such as that used on venetian

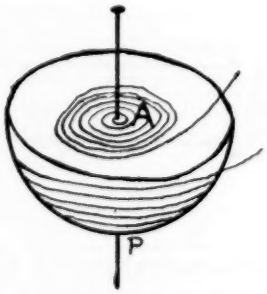

FIG. 6

blinds, and wind it around the nail at the center of the circle at A so that the coil of string covers the cross-sectional circle. Cut this string loose and lay it aside. Take another piece of the same string and wind it about the nail at P until the whole surface of the hemisphere is covered. Cut this string and remove it. Now take this second piece of string, double it, and lay it on the table beside the string which

covered the surface of the circle. The doubled hemisphere string is seen to be equal to the length of the circle string. From this, the reasonable conclusion follows that the surface of the hemisphere is twice that of a great circle. Consequently, the surface of the whole sphere is four times the area of a great circle. Notice that we have used the expression, "the reasonable conclusion follows." We have not given a rigorous proof. The amount of rigor to be used and the degree of understanding to be expected should always be decided on the basis of the intellectual and mathematical maturity of the students. Observe, too, that the string method can be used to obtain the formulas for the areas of the surfaces of cone and cylinder.

VOLUMES

The rectangular solid. What does volume mean? Have a supply of one-inch wooden cubes and an empty box. Have the pupil take the unit cubes and place them in regular arrangement in the box until the box is filled. Then have him count the cubes. The number of cubes is the volume. This experience not only leads to the formula for the volume of a rectangular solid, but also gives an understanding of the volume concept.

The pyramid. Make a cardboard pyramid having a base $A'B'C'D'$ congruent to the base $ABCD$ of a rectangular cardboard box as illustrated in Figure 7, the altitudes being equal. Fill the pyramid with sand or rice or salt. Empty the contents into the rectangular solid.

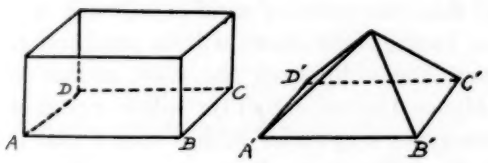

FIG. 7

Repeat until the latter is full. It will be found that the contents of three of the pyramids are required to fill the box. Hence, the volume of the pyramid equals one third of that of a rectangular solid having the same base and altitude.

The cylinder. It was shown above that the lateral area of a cylinder equals that of a rectangle whose base is the circumference of the base of the cylinder and whose altitude is the altitude of the cylinder. Build a box having the rectangle for a base and an altitude equal to the radius of the base of the cylinder. Pour the contents of the cylinder into the box. It will be found to require the contents of two

of the cylinders to fill the box. The volume of the box is $2\pi r^2 h$ and hence the volume of the cylinder equals half of this, or $\pi r^2 h$.

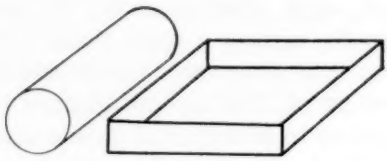

FIG. 8

The cone. A cylinder and cone of congruent bases and equal altitudes can be used exactly as the pyramid and rectangular box to show that the volume of the cone equals one third of the volume of the cylinder.

The sphere. Obtain a hemispherical bowl or half of a hollow rubber ball. Then construct a paper cone having a base equal to the cross-sectional great circle and an altitude equal to the radius of the sphere.

FIG. 9

It will be found that two cones of sand or salt will be necessary to fill the hemisphere. Hence, four cones will be required to fill the whole sphere. However, the volume of the cone equals one third times $\pi r^2 \cdot r = 1/3\pi r^3$. Hence, the volume of the sphere equals $4/3\pi r^3$. Another method is to construct a cylinder with a base equal to the cross sectional great circle of the hemisphere and an altitude equal to twice the radius of the sphere. It will be found that three hemispheres will be required to fill the cylinder. Since the volume of the cylinder is $2\pi r^3$, the volume of the hemisphere is $2/3\pi r^3$. Hence, the volume of the whole sphere is $4/3\pi r^3$.

CONCLUSION

This paper has dealt almost entirely with geometric concepts and relationships of a mensurational type. Those treated are usually first found in the mathematics of the junior high school years. The authors believe that empirical procedures can contribute much to making mysterious formulas less formidable just as they help to give more meaning to arithmetical concepts and operations.

The experienced teacher who has spent time looking for devices to enrich the learning experiences of her pupils will find little that is new in this paper. The inexperienced teacher may find some ideas whose use will pay dividends.

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SCIENCE EMPHASIS DURING AMERICAN EDUCATION WEEK

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From a modest beginning, American Education Week has grown in proportion and significance. Today, it is one of the great annual programs in the education sphere, representing, as it does, the ideals of free public education. This year, the period between November 7 13 has been designated by the Nation's schools as the time for celebrating the twenty-eighth observance of this event.

Science teachers, in addition to emphasizing the topics recommend by the National Education Association, should use this important occasion to conduct a public relations program between their profession, students, and the community. Obviously, the better acquainted students and parents become with science, the more value it has to them. The data which follows suggest activities which may be used toward attaining that objective.

1. Science Posters. Industry knows the advertising value of posters. Students, also, will have their concept of science enlarged through this medium. Selections should include pictures and clippings secured from both published sources and student preparation. Colored pictures, particularly, add attractiveness and arrest notice.

2. Science Talks. Prepared student talks are generally well received by classmates. The following list of topics, among many others, will broaden a student's viewpoint of science. 1. Science contributions, past and present. 2. Famous scientists and their accomplishments. 3. Preparation and qualities necessary to be a scientist. 4. The need for scientists. 5. Science opportunities. 6. Remunerations for science workers. 7. Science fields.

3. Debates. Debating, in the classroom, important current science questions will arouse interest where other methods have failed. The question chosen for debate should be a popular one. Consider, for example, the following: Should The United States Release Atomic Energy Secrets To The World?

4. Project Display. This special week is an opportune one to exhibit worth while science projects. They may be shown in the school library, hall display cases, city store windows, and other prominent places.

5. Night Meetings. Two of the most valuable high school meetings which the writer organized were night meetings. One, an all science program, included a nationally known science educator residing in the State, a well known local industrial scientist, and a chemistry student from our school. This program was designed to bring the State, community, and school into closer relationship. Certainly, there is need for an extension along this line.

The second meeting resulted from the combined efforts of several departments. They were: English, science, art, music, and physical education. Each group presented activities which were typical of its work. The English department gave a short humorous skit. Chemical and electrical experiments were performed by science students. Girls from the physical education department demonstrated modern dancing. Stage scenery was prepared by art students. Music included the school bands, vocal, and instrumental numbers.

A social hour, sponsored by the Parent Teacher Association, followed the formal program. The night performances were presented to large audiences composed of parents and students. Programs such as these enable parents to learn what the schools are doing for the education of their children. Likewise, through school association, parents learn of the need of the schools.

The general theme for the 1948 American Education Week is, "Strengthening The Foundations of Freedom."

The daily topics are:

Sunday, November 7—Learning To Live Together.
Monday, November 8—Improving the Educational Program.
Tuesday, November 9—Securing Qualified Teachers.
Wednesday, November 10—Providing Adequate Finances.
Thursday, November 11—Safeguarding Our America.
Friday, November 12—Promoting Health and Safety.
Saturday, November 13—Developing Worthy Family Life.

Complete information regarding American Education Week may be secured by writing to the National Education Association, 1201 Sixteenth Street, N. W., Washington 6, D. C.

The phenomenon of nuclear fission was a discovery. The nuclear chain-reaction pile was an invention—one of the major inventions of history. It was an invention profound in theory and based on a most sophisticated appreciation of the behavior of different atomic nuclei with respect to neutrons. But its physical features and its mode of operation are remarkably simple.—Davis: *Energy Unlimited.*

THE PROBLEM OF THE SLOW LEARNER

A Study of the "General," "Modified," "Practical Arts," or "Non-Academic" Student of Biology

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I. *The problem:*

A. Today we find more and more pupils in our classes who either lack interest in the traditional offering of subject matter, or whose intellectual capacity is such as to deny them passing grades.

B. Because our academic syllabus in biology which has been tailored to fit the entrance requirements for college does not answer their needs, they become misfits in the ordinary class. Hence, in ever-increasing numbers they have been placed in classes having a modified procedure and simplified course of study.

C. Such special classes, representing, as they do, an experiment, call for continuous modification if those for whom they were devised are to get the maximum of benefit. In no way are these pupils "second-class citizens" of the school; it is therefore our privilege and opportunity to provide them with every resource, moral, intellectual, and material, at our disposal.

II. *Intellectual characteristics of the slow-learner:*

A. Poor grades mar his educational history. Where he was previously enrolled in regular classes, we often find a sustained history of failure. And when, in the elementary or junior high school, he managed to obtain passing grades, we frequently discover that these were earned in slow-moving classes.

B. It can only be estimated—since the necessary data have yet to be obtained—that at least half of these pupils have intelligence quotients below 90. On the other hand, it should not be neglected that the balance of them are approximately of normal intelligence so far as the results of mental testing provide us with an acceptable index of normalcy. We should further bear in mind that an intelligence quotient of below 90 does not necessarily indicate inability to do normal school work.

C. The non-academic pupil will not be up to others of his age group in speech and writing skills. He tends to express him-

self faultily. Sentences are incomplete, rambling, and poorly phrased. This defect may sometimes be traced to congenital factors. Often it is the result of an unfavorable pre-school environment. Occasionally we find that poor command of English stems from such emotional blockages as shyness, resentment at a history of scholastic failure, or allegiance to one's group where "rough-and-ready" language is resorted to as a proof of belonging.

D. Because they lack interest in and, therefore, the ability to grasp abstract ideas (though some will argue that the absence of ability precedes the lack of interest), they remain indifferent to the intellectual abstractions which are at the core of the traditional secondary school curriculum.

E. Their approach to problems is slip-shod. Thus, they lack patience in assembling data, fail to associate data in a coherent system, and are prone to dispense with proof where—as they suppose—bare assertion will do.

F. Ruled, as they are, by group-thinking, a slogan suffices with them for explanation. However, in this respect they differ from the normal not in kind but in degree.

III. *Social characteristics:*

A. Their thinking is largely confined to personal problems. Thus, they want the approbation of their fellows. They are concerned with the choice of a vocation through which they hope to recoup the losses in self-esteem occasioned by scholastic failure. They dwell upon sports or affectional relations. But less personal issues pertaining to current events, literature, science, art, politics, religion, etc., possess very little interest for them.

B. Filled with resentment at having to attend school, the retarded pupil tends to be unfriendly towards his teachers. He will take the earliest opportunity to leave school and thus escape from us. On the other hand, he is much more responsive to a sympathetic teacher than is the pupil of average or superior intellect. Thus, he reveals more of himself to the instructor he can identify with himself. But where non-academically minded pupils feel no interest on the part of a teacher—and they are quick to note this lack—they will act as an obstreperous clique. They will all share in one opinion—and one plan of offensive!

C. Segregated, as they increasingly are, in a school within a school, they develop feelings of persecution. This causes them to cling together so that with each other they mani-

fest an extreme of gregariousness and do not readily make friends with the rest of the student population. This conduces to similarity of thinking. They tend to think as a block, and to frown upon any expressions of individuality.

D. Their feelings of inferiority come to a focus in the worship of heroes. Naturally, these will not be pioneers in the field of thought since appreciation of accomplishment here is beyond them. To our frequent despair, they rather, hold in esteem the athlete, radio comic, popular musician, and the like.

E. Like most of our students, they mean to be good children. But often the feelings of frustration and resentment generated in school will be directed against a parent who seems to lack sympathy and understanding. Parents, too, will be disappointed in a son or daughter who does not measure up to their dreams. Often they will not know better than to irritate rankling feelings of inferiority.

F. In class responses, they display poor self-control, being given to answering in chorus to the distraction of the teacher. But this cacophony has its remedy as well as its cause. As the teacher wins them over, they will reveal that cause to him—quietly.

IV. *Health and psychological conditions:*

A. Many of them suffer from cardiac conditions, hernia, asthma, impaired vision and hearing, poor motor coordination, glandular disturbances, etc. We find extremes of development. But the majority enjoy average or better than average health. The boys will often be members of school teams and, by virture of their size, are much in demand as traffic squadsmen.

B. They tend to display extremes of restlessness which are sustained. The pupil who is restless will often be so whether or not interested in the lesson. He seems always to be surcharged with nervous energy which he cannot control. And the apathetic child, even when momentarily aroused, will preserve a stolid cast of countenance. So that their psychic life proceeds, in general, with little variation. They are all one personality rhythm, one expression of behavior. This consistency should by no means be viewed as a pathological condition. Fundamentally it is to be traced to a long-existing insensitivity to people and events about them in consequence of which thoughts, emotions, and volitions proceed at their own rate without being modified

by external circumstances. Which is to say, they are the creatures of whatever impulses move them. These they see no reason to curb for the reason that they remain insensitive to social approval; more particularly, they are indifferent to the suasions of adults. While this explanation is the one I personally prefer, the existence of others is granted. Thus, a former pupil of mine, a graduate of the non-academic school, asserts: "What do you expect of prisoners in the presence of their jailor? Will they not show a consistent behavior? The unhappy ones will be morose though the jailor calls it apathy. And those whose thoughts turn to freedom will be restless so long as they remain caged."

V. *Moral characteristics:*

A. Many of these children are regular church-goers. For the most part they are, as we have said, affectionate children. Toward their own friends they are indulgent, even sacrificing. But because they have no large scope of thought, charity and the application of simple moral principle begins and ends within the restricted circle of their relatives and acquaintances. Can we therefore stigmatize them as being morally inferior? Of course we can—and do. Yet we might well ask ourselves whether our own application of morality extends further than those near and dear to us. To be sure, those near to us should indeed be dear, but nearness is more than a matter of geography and dearness more than a reflex to services anticipated or rendered.

B. It is said that these slow-learners supply a large percentage of our future delinquents. However, to assert that a considerable percentage of them turn later to crime is by no means to set them apart from the rest of the population. We have to know more precisely how law-abiding is the average citizen, what types of crimes he commits, and how successful he is in avoiding detection. Without in any way condoning theft in which violence is unmistakeably involved, such misdeeds as income tax evasion, the adulteration of foodstuffs, misleading advertising, etc., belong just as surely in the category of crime.

VI. *Environmental factors:*

A. Children who are intellectually inferior will usually come to us from homes of a low economic status. And this would indicate that their mental and other disabilities are ac-

quired rather than inborn; at least, a poverty-stricken environment has never been known to be conducive to intellectual competence. The strong mind that comes from a poor environment is strong in spite of neglect and squalor, never as the consequence of them. But some will maintain that the fact that these students come from a poor environment proves that they are of defective stock, that they inherited their defects from parents whose incompetence caused them to lag behind in the race for economic security. This is to say, then, that the shrewd business man is more of a success as a thinking-feeling human being than is his struggling employee. We readily grant that in some cases this may be so, but if the employer is *always* better than those who work for him, we wonder why he, the possessor of greater intelligence, should not have more strenuously exerted himself to lift them up. We conclude that neither material prosperity nor poverty is a desideratum of intelligence; also, that it more promising to proceed on the assumption that defects of intelligence, whether inborn or acquired, are always remediable.

B. While there is often very little intellectual stimulation in the homes of these retarded pupils, the parents are usually eager to secure the benefits of education for their children. We cannot blame parents for failure to provide a stimulating mental environment. Where they suffer the fate of overworked drudges, they can do little more than feed and clothe their children. And where fathers and mothers evade their responsibilities by succumbing to one or another distraction, we shall not be so quick to criticize them if we remember that they also went to school. So that if, as a result of faulty nurture, a child has been turned away from reason and reasoning behavior, it is up to teachers and administrators to give him of their best thought. Though it may momentarily relieve us to complain of parental deficiencies, mere complaint is in the long run useless. Parents mean well but are untrained. Teachers are not only trained, but are paid to compensate for parental deficiency. Were parents perfect, they would be teachers and our services could be dispensed with.

C. Parents of slow-learners will often lack knowledge of child-training (which, by the way, is just as often true of the parents of brighter children), so that frequently they exert little control over their offspring. Perhaps this represents a progressive movement in the American domestic scene

where all parents may eventually be relied upon to be seen, and not heard. More seriously, knowledge of the child-mind is given to few; parents can therefore not be singled out for backwardness on this score. And as knowledge of the child is the indispensable prerequisite to all worthwhile instruction, those who would deserve the name of teacher will apply themselves to the investigation of the natures of those in their charge. We cannot succeed in this if we remain outsiders. But if, through greater knowledge of what we do, we see that our needs are mirrored in the needs of all people, we shall more closely identify ourselves with those in our care. Then, on the basis of more reliable insight, we can proceed with greater competence in awakening immature minds to the intelligence within them that makes of them their own problem-solvers.

VII. *Implications for the teacher of biology—motivation:*

A. We recall here the advice of Lincoln to Isham Reavis, a young man who aspired to read law with him. "If," wrote Lincoln, "you are resolutely determined to be a lawyer, the thing is more than half done already." So with the teacher who would make his work advantageous to these pupils. If he is at all interested in them, he stands in no urgent need of anyone's advice as to how to go about teaching them. And if he has not the interest, he will be unable to use any advice to good advantage. While I do not doubt that teachers have, by and large, the indispensable interest, certain recommendations will nevertheless be offered which, I trust, are not altogether without merit. I do so in the hope of being corrected where I am mistaken and of being encouraged where my experiences and what I have deduced from them are corroborated by the findings of my readers.

B. Motivation means simply the introduction of students to subject matter so as to arouse not a momentary but a sustained interest. It may be analyzed into three elements which compose the triad of instructor, instructed, and instruction. Now as all three involve mind or products of mind, much complexity enters. Shall we then petition our Board of Education to purchase for us an electronic calculator so that we may obtain the perfect motivation? By no means. But as we are really concerned with the student, we shall get to know him better. As we are interested in subject matter as a clearing in a wilderness of mystery

which is the cosmos, we shall know what we teach to be a knowledge good to have. And as we are interested in making of ourselves the best possible persons, we shall ensure that interest in the student and subject matter does not peter out with our years of teaching. These three elements taken care of, good motivations will invariably emerge. They may not be perfect, but they will be the best we can think of. Surely no one can fairly criticize us for doing our best.

C. For the traumatically withdrawn personality, disregard motivation. All you can do, at least in the beginning, is to win this confidence. Entrust him with little chores; fortunately, biology offers many. And be on the lookout for special aptitudes, in particular, artistic ones. He will gladly do pictures for you, make charts (often better than you can buy), work with clay, arrange and take care of classroom aquaria and terraria, etc.

D. His brighter classmates, though perhaps dull as compared with our academic students, can also be approached through their special interests. If they are partial to music, the following motivations can be used:

1. The calories required to play the flute as compared with the number required by the drummer.
2. Incidence of tuberculosis among famous musicians.
3. Races of men—typical rhythms and tempos of music.

Should sport enlist their interest, the following are suggested:

1. The laws of chance and matching pennies.
2. Heredity and horses.
3. The survival of the fittest and the World's Series.
4. Stick-ball: a study in conditioned responses.

The girls—and, to a degree, the boys—will be interested in home duties and chores. Try the following where the school population is of mixed racial types:

1. Classification and typical Italian delicacies (squid, snail, and sea urchin eggs).
2. How dishes are hygenically washed and dried.
3. Traditional Jewish cookery as an instance of unbalanced diet. (Excess of fatty foods.)

E. We may find many in the non-academic school who mentally are alert enough but whose intelligence is masked by indifference or enmity towards everything that the school stands for. However, the urge to compensate for the ensuing failure to learn remains and expresses itelf in the form of

interest in the two major adult concerns which are vocation and affectional relationships. And this suggests the appropriate motivations:

1. Working papers and heart murmur. (In connection with the circulatory system.)
2. The evolution of the aeroplane as an introduction to biological evolution.
3. What the "sidewalk superintendent" sees. (To introduce the student to the topic of specialization of cells and division of labor.)
4. What makes the automobile go. (As the motivation for human metabolic functions.)
5. Baby watching. (To compare mammalian emphasis upon care with sub-mammalian emphasis upon quantity of offspring.)
6. How to be attractive. (In connection with the themes of nutrition, structure and hygiene of the skin, etc.)
7. Types of friends. (As an introduction to taxonomy.)

F. Because these are not the usual textbooks motivations, a word may be called for in defense of what to some may seem to verge upon vulgarity. I think now of the dung beetle that treasures excrement in which to lay its eggs. Moved by maternal fervor, it will travel a considerable distance to obtain this—to it—precious substance. Even so the teacher will not hesitate to avail himself of every possible appeal. He will not be squeamish about his motivations. If they move the unblinking to blink, to wonder, and to ask, he will use them.

VIII. *Use of textbooks:*

A. When we assert that these students are non-academic, what we more accurately should say is that they are poor readers. While the good reader is not necessarily an original thinker, the fact remains that reading disabilities constitute a most serious obstacle to scholastic success. However, failure to master the printed word is by no means an incurable defect, But if we want to do something about it, we must have the proper textbook which at least in the field of biology, has yet to be written. Such a book would have to rely not upon an extensive glossary of terms but upon simple language; its choice of vocabulary would follow from knowledge gained at first-hand of the abilities of those who are to read it. It would further have to be copiously supplied with illustrations possessing a maximum of

visibility and dramatic appeal. Above all, it should make for interesting reading. We do not think, to anticipate a possible objection, that these recommendations are at all subversive of science. For science, far from being undramatic, is a veritable treasure house of absorbing biography. No less than the arts which deal with word, tone, and color, or the disciplines which are philosophy and religion, science is a record of men who sometimes faltered yet never altogether abandoned their fated struggle to know the nature of life, the conditions in which it exists, and the goal—greater consciousness—towards which it aspires. Were their story—and it is really your story and mine—recounted just as it had happened, who could remain unmoved? But there lies Canaan, and here we wander in a wasteland of arid texts, one dreadfully like the other. Which is to say, Lord have mercy on our students, for we have none!

B. Upon the teaching side, it is imperative that we emphasize:
   1. Much silent reading.
   2. Power in explaining what is read.
   3. Drill and practice in summarizing meanings.

Enhancement of reading power is fundamental to redeeming these children out of academic failure. To turn their defects into strength, emphasis upon remedial reading techniques is called for. They must be encouraged, if not to read more than the academic student, at least to read more economically, more intensively, and—we hope—more understandingly. If one cannot get them to read a chapter, then a section, a paragraph, even a sentence, will suffice. The proof of grasp of meaning lies not only in accurate reproduction but in application: are they able to see how what they have read applies to themselves, to what they know and have previously experienced. Like everyone else, they have an "apperceptive mass," and it is to this that the teacher will at every moment appeal. He cannot, therefore, look upon their experiences and judgments as altogether valueless, as crude, stereotyped, and vitiated by error. But while he does not begin anew, he does build upon what they know, helping them to replace error-laden judgments with thoroughness, originality, and insight. Though not all will come to appreciate and to apply these gifts in the same span of time, they are nevertheless for all. If humanity is ever to know the security and happiness engendered by thought, not only the king but the most benighted of his subjects must become a philosopher. Or

we may say, culture is for everyone or it is for no one.

IX. *Visual aids:*

A. Visual aids—slides, charts, photographs, motion pictures, etc.—are not adjuncts of the textbook; they are but another aspect of it. Being so, what we have said of the textbook applies in every respect to visual aids. The criterion upon which we rely in gauging their usefulness is not expensiveness, up-to-dateness, or even convenience, but the learning derived from them. We want to know: Do they explain themselves simply and cogently? Are they drably factual or are the facts they contain enlivened with a modicum of imagination? Is a mass of information presented to the student, much too bulky for him to digest? Is time permitted for review, drill, and assimilation? Where quality is sacrificed for quantity, there is neither quality nor quantity but only confusion and certainly no learning.

B. Ample board space; a microscope for each student; a terrarium, too; display cases and a large aquarium for the classroom; a greenhouse and museum for the school—these we urgently require. And as we set about in earnest to fulfill our oft-reiterated promises in regard to building a better world for the young, we shall also have, adjacent to the school, an acre or so of good land for farming, a woodlot, a natural or artificial lake, tool sheds, barns, etc. Is this really so impractical? Today?—of course! But what legislator could tomorrow deny the request of his teacher who taught him to reason and to feel? Let the teacher really learn how to teach and every purse in the land would open at his request. Let the teacher really become the teacher and every purse in the land would have enough and to spare.

C. This is not to say that in the meantime, we must resign ourselves to ineffectual teaching. The ingenious instructor will readily think of a host of simple visual aids which he or his students can easily and inexpensively construct.

X. *Class control and discipline:*

A. Although a good teacher may have fifty pupils in a class and yet have no problem of discipline, while his poorer colleague will be unable to control one, the most opportune instruction of the dull-normal pupil calls for smaller classes, perhaps restricted to a maximum of twenty.

B. The problem of discipline becomes exacerbated when the

instructor of the academically retarded pupil resents having to teach him, preferring the brighter (but often only seemingly so) pupil. In this case, it is needful that the administrator judiciously select those who are to teach the poorer pupils. Should his teaching staff volunteer to do so, the administrator may well congratulate himself. Where they do not, he, as a teacher of teachers, has much work ahead of him. But as example is always more effective than percept, we may hope that as a beginning he will be willing to take one or two of these classes himself.

C. The teacher of the retarded pupil is advised to avoid all stigmatization, lecturing, or scolding. But as he is a human being and no apotheosized saint, we expect him to be so concerned with the well-being of those in his charge as occasionally to lose his temper. Provided his relations with his students are of such a caring quality that they know his admonitions to be well-meant, an occasional flaring-up on his part will not prove detrimental. Of course, he will not always be finding fault. He will be liberal with his praise though avoiding over-generosity. And through the learning exercises he sets them, they will derive a feeling of tangible accomplishment which should eventually obviate most discipline problems.

D. Yet even with the best teaching, there is still the problem of discipline. We do not criticize the effectiveness of Christ's instruction when we point to a Judas among his disciples. Men, even the best of men, are always confronted with the problem of self-discipline, the answer to which lies in self-knowledge. If the student is not taught to refer his actions to himself as their agent, responsible or otherwise, his control over himself is always unreliable, disappearing when he is unwatched. It follows that such external means of enforcing discipline as marks, exhortations, intimidation or actual punishment, are only to be viewed as negative aids. Though we may continue to use them, we shall only do so in the understanding that positive growth in the direction of self-control begins when the student is encouraged to be interested in himself, in the manifold and complex expressions of his personality. Wrong social attitudes inevitably arise in the alienation of the individual from himself. Failure to distinguish right from wrong comes always through the failure of the individual to identify what happens to him with his deeds. So

that to straighten out the twisted, the student will have to be taught to know something about his actions, to scrutinize them in a spirit of neutrality for what they are and do to him. Only so can he know who his true enemy is and, in dealing with that enemy, become his own most capable guardian.

XI. *The development of the lesson:*

A. So long as there are naive minds about, there will always be some who will argue on behalf of the one best method of teaching, and others who will hear them out and agree. In reality, there is no single method that is in every respect superior to the rest. My method is not your method, so that if you try mine you will certainly not obtain my results. And if I try yours, the results will be just as surely disappointing. If, then, we can at all speak of a best method, it is the method best suited to the individual instructor. But while best for him, he can always do better with it; he must therefore always be on the alert in seeking for ways and means to better his past performances.

B. Because he is easily bored, the academically retarded pupil requires a varied approach. His teachers should therefore be versed in the activity method, supervised study, the method of the recitation, and so on. But this variation is necessary only in the beginning. As the instructor increasingly enlists the interest of his classes, we leave it to him to employ whatever method he personally prefers. Most likely he will fall back upon the traditional method of the recitation. But should he do so, he must remember that the teacher is not the sole reciter. The burden of instruction (in the form of reports to class, demonstrations, blackboard explanations, etc.), should increasingly fall upon the student, first upon the stronger who will assist the weaker, and eventually upon all.

C. Work in committee and the socialized recitation are not for all personalities. Where there is much objection to working in a group, the instructor will not insist upon it providing those who object contribute, as they are able to do so, to the learning of the class. Where students are unfamiliar with any of these suggested methods, the teacher introduces his classes to them gradually, tactfully, and with every necessary explanation.

D. When many types of activity go on, some simultaneously, there is considerable danger of the class deteriorating into

a circus. But where attention dwindles, the teacher will be quick to take note of this fact and to try something else. Incidentally, that "something else" will include interims of rest and relaxation for the students, pauses to stare out of the window at the sky, to quietly talk among themselves of something else or to say nothing. You and I relax just so when we have done strenuous mental work. So why not they? But as time goes on, there should be less and less need of change in procedure. Instructional units should simultaneously lengthen and deal with more and more abstract subject matter. In other words, these classes should, if our work is at all successful, gradually become indistinguishable from normal classes.

E. While we shall provide for the needs of these students by means of diversified activities, under no circumstances should we indulge their weaknesses. They are to be held up to a standard of achievement consonant with their capacities. And this calls for frequent reviews, drills, tests. Well motivated and carefully organized assignments should be given them, and their answers should be discussed and evaluated in class. Skill in organizing information is to be encouraged through insistence upon a neat, accurate, and original notebook to be periodically inspected and graded. We need not fear that they will object to our insistence upon reasonably high standards. Those who have taught them know that they are quick to appreciate our efforts here.

F. In grading tests, notebooks, class responses, etc., we compare the achievement of a student not with another's achievement but with his own. He and no other is our standard of comparison. Like the physicist who abandons absolute time and space, we make the student his own ultimate standard and frame of reference.

G. By all means encourage the student to keep a scrapbook but make certain that it is coherently organized and not just an indiscriminately arranged assortment of odds and ends culled from any and every source. The scrapbook should be an integral part of instruction and not just a device to prevent restless minds and hands from getting into mischief.

H. The use of classroom games is to be discouraged. Without minimizing the seriousness of education, it becomes a game when there is interest in it. Besides, the retarded student has had enough of play for play's sake in the past, and this

fact may explain, at least in part, why intellectually and emotionally he is what he is. This is not said because I frown upon play; what I am rather attempting to do is to enlist play in the service of learning. Have you not often explained to your students that one ambitious to be an athlete has to submit himself to rigorous disciplines if he would ever master a particular sport? And did you not go on to say that the ambitious pupil must likewise submit himself to an equally exacting course of discipline if he would ever master that most exhilarating—and strenuous—of sports which is learning?

I. Emphasis is placed upon knowledge as social competence; not upon social competence as an attribute of personality somehow distinct from knowledge. There is, to be sure, the scholar whose researches—and they are often brilliant—bear no fruit in the form of socially enlightened behavior. But the learning of the well-rounded scholar makes him more and not less of a human being. We learn from him that application to search and investigation make of one a better friend, husband, father, citizen, son of God. If he is a biologist, we call him Pasteur, Koch, Mendel, Darwin (who was never irreligious), Semmelweiss, Roux, Ehrlich, von Behring, Noguchi. What does this require of the teacher? Obviously he must be more than just a scholar immersed in the textbook, speaking like a textbook, knowing no more of himself and his students than what he can decipher of the textbook. And this means that his scholarship must at every instant enter into his life and conduct so that in whatever he thinks and feels and does, he gives evidence of knowledge. Thus, if he refers to evolution, he must, at the same time, be able to provide for his students an example of evolved behavior, that is, the behavior appropriate to a thinking-feeling human being. And this is social competence in its only practical sense. If he mentions the collaboration of specialized tissues in the metazoa, he must be able to exemplify collaboration in his dealings with others. To take still another example, if he speaks of selective breeding, he must illustrate selectivity in the choice of his actions, discarding the worst and selecting the best upon which to build. A myriad of other illustrations come to mind, but it is hoped that these few will suffice.

XII. *Pupil participation:*

A. In all classes, non-academic or otherwise, the degree of

pupil participation in the lesson is always in inverse proportion to the amount of subject matter than can be covered. This fact should be taken into account by those who construct the curriculum. Insofar as pupil participation is to be encouraged, the work to be covered will have to be cut down.

B. We teach not as we have been advised to teach but as we were actually taught. And this interposes another obstacle in the way of pupil participation. It does so because we have been academically trained and are therefore accustomed to the method of lecturing which is followed by catechizing on the part of the instructor. Here, the mediocre student plays, at best, a minor rôle so that this method, as it is generally applied, is not at all suited to non-academic classes. To give the teacher skill in other instructional techniques, besides helping him to improve the lecture method so that it will stimulate interested discussion and evoke some originality of thinking, it is up to the administrator to arrange for "Alertness" or "In-Service" courses where the necessary techniques may be observed. Successful teachers should be encouraged to volunteer their services here.

C. A word of caution is called for: In this day when the untrammeled gushing forth of words—any words— is construed to be democracy, pupil participation may easily be overdone in which case it becomes a vice. The teacher, we think, has something to say and should have no hesitancy in assuming the leading part in the classroom. He has therefore the delicate work of encouraging on the one side, the maximum of pupil participation and, on the other, of providing for his classes a living example of good sense.

XIII. *Curriculum modification:*

A. To some this may seem the paramount consideration in any program designed to better the instruction of the backward pupil. Others, myself included, are unable to concede the importance of revising the syllabus. To take an illustration from biology, there is virtually an infinite variety of foods from which to choose in achieving a balanced diet. Since the body will thrive upon practically all combinations, what proves deleterious is not so much the food as its preparation. Analogously, it is not our subject matter which is faulty, but the way we present it. The proof seems very obvious: the good teacher is able to extract tuitive

significance from any topic. Thus, Huxley found a world of meaning in a seemingly inconsequential piece of chalk. But the tides of pedagogical innovation press in upon us, and though we know very well that they must recede again, we cannot take the part of Canute. By all means, then, let us reform the curriculum, only let us make sure that we deal better with the new than we have done with the old.

B. By what canons shall we revise the curriculum? Our choice of criteria will inevitably depend upon the sort of person we are. The sort of person we are will determine, in turn, the kind of future we envisage for our students, and our view of what lies in store for them will be the ultimate determinant of what we do in the way of revising the syllabus. If, on the one hand, we tend to authoritarianism, we shall, though with every benevolent intention, construct for non-academic pupils a course of study which will further serve to set them apart from intellects we qualify as being normal or superior. And if, on the other hand, we are democratically inclined, we understand that what is good for one is good for all. If there is one body of truths, then it must exist for all, though not all will achieve its understanding in the same time or with the same expenditure of effort. The findings of a Pasteur or Metchnikoff, as of a Socrates or Spinoza—of those who made it possible for men to live, as of those who made it possible for men to live well —are for all. And even though it takes one a lifetime to learn that they indefatigably labored to come upon fact, then one's time was not misspent.

C. If, then, we are seriously thinking of how to retrieve these children out of failure, we shall have to think just as seriously of what they will be once they are retrieved. Since they poignantly look forward to being placed in a normal class, if we cannot help them in this, then we have failed them. It seems little enough that they ask, and as we are neither heartless nor unskilled in the arts of teaching, we will help them to translate their dream into reality. We will do so by making it possible for them to be transferred into an academic class with a minimum of difficulty. The curriculum we devise for the non-academic student of biology must accordingly be patterned after the academic syllabus. If there is any deviation, it will be in the direction of providing more opportunity to develop aptitude for accurate observation, concern with establishing relationships, and interest in the systematic generalizations which

make of science a progression beyond the uncorroborated beliefs which are at the core of common sense.

D. While there are some who have every confidence in the potential ability of the so-called dull child to complete the normal academic course and that without dosages of glutamic acid, there are many more who are quick to label them incurable sentimentalists. But before one does so, he must be certain that intellectual deficiencies are the consequence of heredity and therefore incurable. To be quite certain of this, he must first have extended himself to the utmost to transmute his pupils' weaknesses of mind into strength. If he did extend himself but failed, he must further be sure that it was their inadequacies that stood in the way and not his. One recalls, in this connection, the judgment of incompetence passed upon young Darwin by his instructors. Mendel, too, was the victim of appalling short-sightedness, twice attempting to take a scientific degree at the University of Vienna and both times failing. One also recalls that before Binet had beguiled us with his siren song of prestige and power, promising to make of us unerring arbiters of intellectual competence, there were other educators—Pestalozzi, Froebel, and Mann, to mention just a few, who were not so much concerned with keeping keys as with opening doors.

XIV. *Selection and guidance of the non-academic pupil:*

A. In selecting the student personnel of non-academic classes, the parent should be *fully* advised as to the merits and demerits of segregation so that he can, on the basis of knowledge of the facts involved, make the final decision as to placement. It is to be hoped that both father and mother will consult the child's wishes for we do not wish him to be a passive pawn.

B. Where both parent and child are opposed to segregation, their wishes should be heeded and the child enrolled in a regular academic class regardless of his scholastic record or intelligence test scores. However, they ought both to be given to understand that failure will either defer the obtaining of an academic diploma, or involve placement in a non-academic class.

C. Should the so-called dull-normal student who elects to take an academic course fail to secure passing grades, he should be given the option of either continuing in this course with the necessity of making up the subjects he has failed, or of

transferring to the non-academic course where he will be credited with whatever subjects he has failed. But if, following placement in the non-academic course, he proves himself capable of doing normal work, he should be reprogrammed into the academic course without losing credits for subjects successfully taken in non-academic classes.

D. Students who follow a non-academic curriculum (a more accurate nomenclature suggests the use of the term "modified curriculum"), should have the benefit of at least one period a day of intensive supervised study. During this time, they are to be assisted by those who actually instruct them, not by teachers of other pupils. A specialist in remedial reading should, for the best results, be assigned each study group. It is hoped that no such group will contain more than twenty students.

E. The modified student should further be given the benefit of at least two periods of guidance each week when the school day is to be lengthened. Or, if this is not feasible, the necessary time may be obtained by requiring of them one less period per week of physical training and of drawing. During these guidance periods, they are to be supervised by the "Non-Academic Advisor" who will be selected by the principal of the school. The advisor should be aided by a team of workers from the Bureau of Child Guidance, comprised of a psychologist, physician, and at least two social workers. All students in the modified or non-academic school meet together during these two periods at which time they will be given individual and group guidance by the advisor, psychologist, physician, instructors in the modified school, etc.

F. During two weeks of the term, one at the beginning of the semester and the other at its close, the students will attend classes for only part of the school day. When they are dismissed, teachers will visit homes, interview parents at the school, study guidance records of pupils, and consider with each other ways and means of improving the calibre of instruction.

XV. *Final recommendations:*

A. The non-academic or modified school is by no means to be another vocational high school. Its aims and correlated procedures remain essentially those of the academic high school at its best. Only one difference enters and it is this: remedial techniques come to the foreground of attention.

What we may eventually expect is that the modified student will take nine or ten terms to obtain a diploma, and that from about the fifth term onwards the work will very closely approximate or even be identical with that of the regular high school course.

B. The student should at every point know what is going on and why, so that we may not be hindered by any lack of cooperation on his part occasioned by ignorance. Provided what we do is well-intended, well-considered, and well applied, we may be certain that he will energetically second us in our efforts.

C. The choice of personnel is indispensable to the success of this venture. While we require professionally trained people, having at their command every remedial technique —for this is fundamentally a project in rehabilitation—we want also those whose sympathies are unswervingly devoted to all children, retarded or not. Those moved by hankerings for professional advancement, reputation, or salary incrementation have no place here, for if they are included they will surely set at naught every forward-looking measure. The complacent-minded will also constitute a hindrance. But if, as we strongly urge, the selection of teacher personnel is put upon a volunteer basis, little or no interference may be anticipated from this source.

D. Our value-philosophy differs markedly from that presently prevailing in educational circles in the respect that we are not so fanatically concerned with the learning of the superior student. What is here maintained is that the bright scholar, if he be so in fact, will teach himself. We do not ignore him, but while we give him of our best thought, we do not give him *all* of our thought to the exclusion of the rest of our pupils. In other words, understanding that we can expend but a given energy of mind, we dedicate our major efforts to those who stand most urgently in need of them, to intelligences sapped, we think, not by an inherited but by an acquired ignorance. True, if we do so, we shall not be in a position to claim the credit for the achievements of those of our graduates who in later years manage to distinguish themselves. But if we are at all candid with ourselves, we must admit that it is very little that we can do in guiding those who are eager to learn. We regret that the outstanding thinker should so often complain bitterly in later years that his experiences in school only stood in the way of his maturing—but we know it to be so. Not all,

however, will concede the truth of this consideration and we shall portentously be warned that if the brightest and most promising of our students are to be neglected in the interests of scholastic nonenities, failures who will soon leave us anyway, a speedy deterioration of all our hard-won science and learning is to be expected. In answer, we say, first, that so far as the marvellous instrument which is the human mind is concerned, we are not yet in any position to distinguish reliably between the elite of mind and the mentally undistinguished; second, that even if we could, it would still be true that intelligence is never a fixed power but is always susceptible to growth; and, third, that if we devote ourselves to strengthening the reasoning powers of the poorer student, we shall most directly benefit his brighter fellow. Why and in what way? Seeing what his teachers are striving to do for minds dulled by mal-education, he will want to do likewise. And when he leaves us, we may depend upon him to employ learning and experiment for the good of all instead of not knowing be ter than to use what he has learned in school to bait a trap for the unwary.

MAP AND GLOBE REQUIREMENTS FOR TEACHING GEOGRAPHY IN THE FIFTH AND SIXTH GRADES

LAURA LOUISE WATKINS
Lincoln School, Cicero, Illinois

GENERAL REQUIREMENTS

Globes

The globe is a necessity in the efficient teaching of geography. For fifth and sixth grades it should be the twelve-inch, cradle type, which can be readily handled by the child. For best results, it should be physical or physical-political, with symbols clearly defined.

The globe is a scale model of the earth itself and can, therefore, show most accurately the shapes of land areas and their relative sizes. It gives that world viewpoint so gravely needed today. The child, by turning the globe, can see the earth as it is seen by people in South Africa, North Alaska, London, Tokyo, or any other place.

Maps

The maps used should be relief, physical or physical-political. In these grades, there is no more place for the complex, abstract political

map than there is for complex, abstract mathematical or scientific problems. Maps should be legible from any place in the average classroom, their physical areas and symbols should be clearly defined and easy to understand.

Distortions in maps will be more easily understood if there are one or two hemisphere and interrupted projections. These maps are an easy transition from the globe, and the basis for a clear understanding of all projections.

Project maps for individual and group work are excellent aids in teaching geography. Translating map knowledge into visible symbols is a worthwhile activity, and the result is concrete evidence of a child's progress in understanding.

Charts which show enlarged pictures of map symbols, such as peninsulas, islands, straits, seacoasts etc., are of great value. Such charts aid in map interpretation.

Specific Requirements

Fifth Grade

1. Globes
   - Twelve-inch, physical-political, cradle type
2. Physical-Political Maps
   - World
   - North America
   - United States
   - South America
3. Special maps of United States showing
   - Relief
   - Vegetation
   - Rainfall
4. Project Maps
   - United States
   - North America
   - South America

Sixth Grade

1. Globes
   - Twelve or sixteen inch, physical-political, cradle type
2. Physical-Political Maps
   - World
   - Europe
   - Asia
   - Africa
   - Australia
3. Relief Maps
   - Europe
   - Asia
   - Africa
   - Australia
4. Rainfall and Vegetation Maps
   - Europe
   - Asia
   - Africa
   - Australia
5. World Maps showing
   - Distribution of population
   - Distribution of products
   - Types of Work
6. Project Maps
   - Europe
   - Asia
   - Africa
   - Australia

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON
State Teachers College, Kirksville, Mo.

This department aims to provide problems of varying degr.es of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the department desires to serve its readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

LATE SOLUTIONS

2079, 80, 1. *Helen Angela, Royal Oak, Mich.*
2077, 8, 9, 80, 1. *A. L. Peek, Urbana, Ill.*
2082. *W. R. Warne, Alton; Emmet Brown, Edmonton, Canada.*
2079. *W. B. Judd, Concord, Calif.; A. F. Gilward, Chicago.*

2083. *Proposed by Felix John, Ammendale, Md.*
Show that the roots of the equation

$$x^4-px^3+qx^2-rx+\frac{r^2}{p^2}=0$$

form a proportion.

Solution by Marvin E. Hartig, Evansville College, Evansville Ind.

If the roots are a, b, c, d, then

(1) $$a+b+c+d+=p$$

(2) $$abc+abd+acd+bcd=r$$

(3) $$\frac{abc+abd+acd+bcd}{a+b+c+d}=\frac{r}{p}.$$

The left member of (3) could result from the equality

(4) $$\frac{abc}{a}=\frac{abd}{b}=\frac{acd}{c}=\frac{bcd}{d}$$

(5) $$bc=ad=ad=bc$$

$$\therefore \quad \frac{a}{b}=\frac{c}{d}.$$

Solutions were also offered by Alan Wayne, Flushing, L. I., N. Y.: W. A

Richards, Riverside, Ill.; Max Bebeman, Nome, Alaska; F. L. Miksa, Aurora, Ill.; A. MacNeish, Chicago; W. R. Warne, Alton, Ill. M. D. Eulenberg, Chicago: C. W. Trigg, Los Angeles City College; Hugo Brandt, University of Maryland.

2084. *Proposed by Jack Couch, Hanceville, Ala.*

A yard is in the shape of a circle with diameter 100 yd. Two perpendicular diameters NS and WE are drawn. A light is located at S (South). A boy walks from W (West) toward E at a speed of 5 mph. At what rate is his shadow moving around the edge of the yard? At the point NW (mid point of arc WN) what rate is the shadow moving?

Solution by V. C. Bailey, Evansville College, Evansville, Ind.

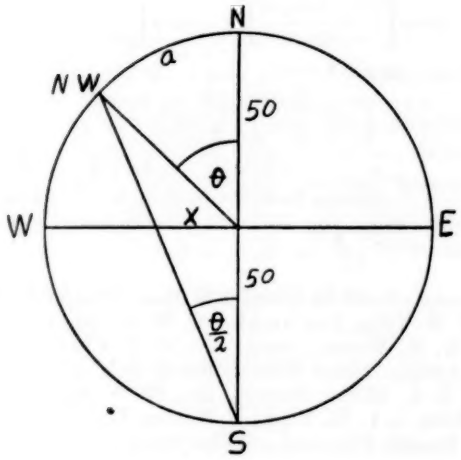
$$x = 50 \tan \frac{\theta}{2}$$

$$\frac{dx}{dt} = 25 \sec^2 \frac{\theta}{2} \cdot \frac{d\theta}{dt}$$

$$\frac{d\theta}{dt} = \frac{1}{5} \cos^2 \frac{\theta}{2}$$

$$a = 50\theta$$

$$\frac{da}{dt} = 50 \frac{d\theta}{dt} = 10 \cos^2 \frac{\theta}{2}.$$



When

$$\theta = 45°,$$

$$\frac{da}{dt} = \frac{5}{2}(2+\sqrt{2}) \text{ mph.}$$

Solutions were also offered by W. T. Cherry, Berwyn, Ill.; F. L. Miksa, Aurora, Ill.; Helen Angela, Royal Oak, Mich.; R. E. Horton, Los Angeles City College; Mary Leona, Detroit; V. H. Paquet, Colton, Ore.; C. W. Trigg, Los Angeles; Alan Wayne, Flushing, L. I., N. Y.; Hugo Brandt, University of Maryland; S. F Field, Ironwood, Mich.

2085. *Proposed by Felix John, Ammendale, Mo.*

If the angles of a triangle are in the ratio of 3:4:5, and if the perimeter is p, find the area in terms of p.

Solution by A. MacNeish, Chicago, Ill.

Let the triangle be ABC with sides a, b, and c.
Then $a+b+c=p$ and

$$\frac{A}{3}=\frac{B}{4}=\frac{C}{5}.$$

Let $A=3x$, $B=4x$, $C=5x$

$$12x=180°$$
$$A=45°$$
$$B=60°$$
$$C=75°.$$

By the law of sines

$$\frac{a}{\sin 45°}=\frac{b}{\sin 60°}=\frac{c}{\sin 75}$$

$$b=a\cdot\frac{\sin 60°}{\sin 45°},\qquad c=a\cdot\frac{\sin 75°}{\sin 45°}$$

$$p=a+a\cdot\frac{\sin 60°}{\sin 45°}+a\cdot\frac{\sin 75°}{\sin 45°}$$

$$p=a\left[\frac{3+\sqrt{3}+\sqrt{6}}{2}\right],\qquad a=p\left[\frac{2}{3+\sqrt{3}+\sqrt{6}}\right].$$

$$\text{Area}=\tfrac{1}{2}ac\sin B$$

$$\text{Area}=\tfrac{1}{2}a\cdot\left[a\cdot\frac{\sqrt{3}+1}{2}\right]\cdot\frac{\sqrt{3}}{2}=a^2\cdot\frac{3+\sqrt{3}}{8}$$

$$\text{Area}=p^2\cdot\frac{4}{18+6\sqrt{2}+6\sqrt{3}+6\sqrt{6}}\cdot\frac{3+\sqrt{3}}{8}=\frac{p^2}{12+4\sqrt{6}}$$

$$\text{Area}=\frac{p^2(3-\sqrt{6})}{12}.$$

Other solutions were offered by Hazel S. Wilson, Annapolis, Md.; O. L. Dunn, Vincennes, Ind.; C. W. Trigg, Los Angeles; C. W. Moran, Chicago; V. C. Bailey, Evansville, Ind.; W. R. Warne, Alton, Ill.; W. J. Cherry, Berwyn, Ill.; Max Bebeman, Nome, Alaska; Helen Angela, Royal Oak, Mich.; Margaret Joseph, Milwaukee, Wis.; F. L. Miksa, Aurora, Ill.; W. A. Richards, Riverside, Ill.; Alan Wayne, Flushing, L. I., N. Y.; R. E. Horton, Los Angeles; Richard Seibby, Milwaukee; Hugo Brandt, University of Maryland.

2086. *Proposed by Charles Reade, Romulus, N. Y.*

Sum the series

$$(1\cdot 2\cdot 4)+(2\cdot 3\cdot 5)+(3\cdot 4\cdot 6)+\cdots \text{ to } n \text{ terms.}$$

Solution by C. W. Trigg, Los Angeles City College

The general term of the series is

$$K(K+1)(K+3)=K^3+4K^2+3K.$$

Therefore,

$$S=\sum_1^n K^3+4\sum_1^n K^2+3\sum_1^n K$$

$$=\frac{n^2(n+1)^2}{4}+\frac{4n(n+1)(2n+1)}{6}+\frac{2n(n+1)}{2}$$

$$=\frac{1}{12}n(n+1)(n+2)(3n+13).$$

Solutions were also offered by M. D. Eulenberg, Chicago; O. L. Dunn, Vincennes, Ind.; V. C. Bailey, Evansville, Ind.; F. R. Close, Hamilton, Ontario; Aaron Buchman, Buffalo, N. Y.; F. L. Miksa, Aurora, Ill.; Felix John, Ammendale, Md.; Alan Wayne, Flushing, L. I., N. Y.; D. McLeod, Winnipeg, Manitoba, Canada; Hugo Brandt, University of Maryland.

2087. *Proposed by Norman Anning, University of Michigan.*

Solve the equation

$$\tan D=-\cot 2D.$$

Solution by William A. Richard, Riverside, Ill.

From trigonometry

$$\tan D=-\cot 2D=-\tan\left[(\tfrac{1}{2}\pi+n\pi)-2D\right]$$

$$=\tan\left[2D-(\tfrac{1}{2}\pi+n\pi)\right], \text{ for all integral values o } n.$$

Hence

$$D=2D-\tfrac{1}{2}\pi-n\pi \ (\pi \text{ is understood to be } \pi \text{ radians or } 180^\circ)$$

or

$$D=\tfrac{1}{2}\pi+n\pi, \text{ for all integral values of } n.$$

(Special values of D would be $\pm 90^\circ$, $\pm 270^\circ$, $\pm 450^\circ$, etc.)

Other solutions were offered by Felix John, Ammendale, Md.; F. L. Miksa, Aurora, Ill.; C. W. Trigg, Los Angeles; Lester Morton, Evansville, Ind.; W. J. Cherry, Berwyn, Ill.; Max Bebeman, Nome, Alaska; Margaret Joseph, Milwaukee, Wis.; Hugo Brandt, University of Maryland.

Editors note on the above problem: This is a peculiar problem. In the above approach, the results do not check since the functions are undefined for say $\pi/2$. Other methods of seeking a solution yield $\tan D=\pm\sqrt{-1}$.

2088. *Proposed by Addison Taylor, Northfield, Minn.*

Solve the system:

$$(x^2+y^2)xy=13090 \quad (1)$$

$$x+y=18 \quad (2)$$

Solution by O. L. Dunn, Northfield, Minn.

Solution: Square (2) gives

$$(x^2+y^2)=324-2xy.$$

Substitute in (1) gives

$$(324-2xy)xy=13090$$

or, reducing, gives

$$x^2y^2-162xy+6545=0$$

from which

$$xy=77 \quad \text{or} \quad xy=85.$$

Then we have the two systems

$x+y=18$
$xy=77$

Solving gives

$x=11,\ y=7$
$x=7,\ y=11$

$x+y=18$
$xy=85$

Solving gives

$x=9-2i,\ y=9+2i$
$x=9+2i,\ y=9-2i.$

Solutions were also offered by V. H. Paquet, Colton, Ore.; C. W. Trigg, Los Angeles; Hugo Brandt, University of Maryland; Max Bebeman, Nome, Alaska; Richard Scibby, Milwaukee, Wis.; D. McLeod, Winnipeg; Helen S. Wilson, Annapolis, Md.; P. S. Marthakis, Salt Lake City, C. W. Moran, Chicago; V. C. Bailey, Evansville, Ind.; Gladys Boyum, Toronto; W. J. Cherry, Berwyn, Ill.; Leslie Briggs, Portland, Me.; W. R. Warne, Alton, Ill.; Naomi Meegraw, Calgary, Canada; J. F. Reinhardt, Alton, Ill.; Margaret Carriger, Alton, Ill.; F. R. Close, Hamilton, Ontario; A. McNeish, Chicago; F. L. Miksa, Aurora, Ill.; Helen Angela, Royal Oak, Mich.; Margaret Joseph, Milwaukee; R. E. Horton, Los Angeles; W. A. Richards, Berwyn, Ill.; Felix John, Ammendale, Md.

HIGH SCHOOL HONOR ROLL

The editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

For this issue the Honor Roll appears below:

2084. *John P. Lazarus, West End, N. J.*
2085. *Dennis Carlin, Jr., Birmingham, Ala.*
2085, 7. *Dwight Conway, Long Beach, Calif.*
2088. *Edward Muecke, Portland, Ore.*

Special Mention

Professor G. H. Frederik of the Gymnasium, Leiden, Holland, sent a group of problems solved very nicely by members of his classes. A committee of boys and girls of his school collects the solutions and translates them into English. The solutions with names are as follows:

2072. *H. Braakman, A. Hilgerson and F. Eskes.*
2077, 2085, 6. *R. Locher.*
2066, 2083. *G. Smit.*
2067. *Anneka Verloop and T. Moens.*
2069. *Anneka Verloop, P. Kuyper, T. Moens and R. Locher.*
2073, 2079, 2080, 2088. *A. Hilgerson and R. Locher.*
2082. *H. Rees, A. Hilgerson, P. Kuyper, F. Eskes and R. Locher.*
2088. *G. F. van Hagen; H. van Wirrgen; R. David; C. v. d. Klaauw.*

The problem department hopes to have more such contributions.

Also from Prasert Na Nagara, College of Agriculture, Baugkheur, Bangkok, Siam, come late solutions to 2077, 8, 9, 2080, 1, 2, 5, 6, 8. Welcome!

PROBLEMS FOR SOLUTION

2101. *Proposed by Grace E. Hicks, Austin, Texas.*

If a, b, and c are unequal, find the conditions involving a, b, c, such that

$$a\cos\theta+b\sin\theta=c$$

$$a\cos^2\theta+2a\cos\theta\sin\theta+b\sin^2\theta=c.$$

2102. *Proposed by Maude Henry, East Romulus, N. Y.*

Solve the two inequalities with positive square roots in all cases:

$$\sqrt{2x+1}+\sqrt{x-1} \gtrless \sqrt{36}.$$

2103. *Proposed by Hugo Brandt, University of Md.*

Find the value of

$$\int_{2\cos A}^{1} \frac{a\,dx}{\sqrt{1-a^2x^2}} \quad \text{for} \quad a=\sin A.$$

2104. *Proposed by August Leecher, Syracuse, N. Y.*

Solve the system

$$(x+y)^3+(x+y)=30$$
$$x-y=1.$$

2105. *Proposed by Bro. Felix John, Philadelphia, Pa.*

A man starts on a journey at 40 mph and reduces his speed by 2 miles every hour for an integral number of hours. If he had maintained the original rate, the journey would have taken $2\frac{1}{4}$ hours less. What was the distance traveled?

2106. *Proposed by C. W. Trigg, Los Angeles.*

Using the nine digits, 1, 2, 3, $\cdots$ 9, one each, form three numbers, a, b, c, such that $a+b=c$ and c is a perfect 6th power.

CENTRAL ASSOCIATION OF SCIENCE AND MATHEMATICS TEACHERS CONVENTION

CLAYPOOL HOTEL, INDIANAPOLIS

November 26 and 27, 1948

The Convention will offer a general program, 8 sectional programs and 5 group programs.

GENERAL PROGRAM

9:30 A.M. Friday. RECENT STUDIES OF THE ATLANTIC OCEAN BASINS. Dr. Maurice Ewing, Columbia University, Leader of the expedition to the famous Mid-Atlantic Ridge.

10:15 A.M. Friday. PROBLEMS OF SCIENCE AND MATHEMATICS IN GENERAL EDUCATION. Third annual forum: AAAS Cooperative Committee on the teaching of science and mathematics. Participating members: G. P. Cahoon, Ohio State University; Prevo L. Whitaker, Indiana University; Lloyd W. Taylor, Oberlin College; Raleigh Schorling, University of Michigan.

11:00 A.M. Friday. GENERAL MATHEMATICS FOR GRADES NINE TO TWELVE. Dr. W. D. Reeve, Professor and Head of Mathematics Dept. Teachers College, Columbia University.

6:30 P.M. ANNUAL BANQUET. THE YOUTH OF GERMANY LOOKS TO US FOR EDUCATION. Dr. Leo J. Brueckner, Member of Education and Cultural Relations Division of the Office of Military Government for Germany (U. S.)

9:15 A.M. Saturday. OUR NAVY EXPLORES ANTARCTICA. Captain of U. S. Navy, George J. Dufek, Commander of Task Force 68, with Admiral Byrd during the 1946–47, Antarctic Expedition.

SECTION MEETINGS

2:15 Friday

CHEMISTRY—*Antibiotics.* Dr. W. Brooks Fortune, Eli Lilly Laboratories.
The Cause of Color in Turquoise and the Cause of Fading. Frank B. Wade, Shortridge High School, Indianapolis.

New Aids for Teaching the Periodic Law. Dr. George A. Scherer, Earlham College, Richmond, Ind.

GENERAL SCIENCE—*Methods of Teaching Science.* Dr. Wilbur Beauchamp, Chicago University.

What Can We Teach in Science? Dr. Morris Meister, New York, N. Y.

GEOGRAPHY—*China To-day.* Dr. Floy Hurlbut, Ball State Teachers Coll., Muncie, Ind.

MATHEMATICS—*Modern Trends in Secondary Mathematics,* Dr. W. D. Reeve.

Panel: Current Experiments in Mathematics Teaching

1. *Functional Geometry:* H. Vernon Price, Iowa State
2. *An Attempt to Measure Critical Judgment,* Dr. Bjarne R. Ullsvik, Illinois State Normal.
3. *Curriculum Exp. in Minnesota,* Donovan A. Johnson, University of Minnesota.

ELEMENTARY MATHEMATICS—*Special Training for Teachers of Arithmetic.* Dr. J. R. Mayor, School of Education, Wisconsin Univ.

The Spiral Development of Arithmetic. Mrs. Lucile B. Gates, Sawyer Ave. Elem. School, Chicago.

PHYSICS—*Research in the Teaching of Physics.* H. Clyde Krenerick, North Div. H. S., Milwaukee.

Planning Your High School Physics Courses. Dr. Philip G. Johnson, U. S. Office of Education.

Breaking Through the Barrier (Jet Propulsion). Robt. D. Beckmann, Allison Div., Genl. Motors, Indianapolis.

GROUP PROGRAMS

ELEMENTARY SCHOOL—*Indiana Plans a Source Book for Teachers of Beginning Science.* Ralph W. Lefler, Dept. Physics, Purdue Univ.

The Role of Teaching Aids in Elementary Science. Mrs. Helen Aufderheide, Jr. High, School 54, Indianapolis, Ind.; Miss Florence Geisler, Jr. High, School 73.

Problems and Methods in Elementary Arithmetic. Miss Mildred Crawford, Mich. State Normal, Ypsilanti, Mich.

JUNIOR HIGH SCHOOL—*Astronomy and Its Place in the Junior High School.* Dr. Harry E. Crull, Head Dept. Math., Butler Univ., formerly Adler Pl.

SENIOR HIGH SCHOOL—*Minimum Mathematical Preparation for Various College Curricula.* Dr. P. D. Edwards, Ball State Teachers College, Muncie, Ind.

Bringing Nature Indoors. Sidney R. Esten, Chief Naturalist, Indiana Pks.

JUNIOR COLLEGE GROUP—*A Thriving Indiana Metropolis of the 16th Century* (Angel Mounds). Glen A. Black, Dept. Anthropology, Indiana Univ.

Mathematics in Science. Mrs. Juna L. Beal, Dept. Math., Butler Univ.

CONSERVATION—*Are Our Cities Worth Saving?* Carl Dortch, Director, Bureau Government Research, Chamber of Commerce, Indianapolis, Ind.

The Future of Our Oil Resources. Dan Hill, Standard Oil of Indiana, Indianapolis.

BIOLOGY—Program in preparation.

ELEMENTARY SCIENCE—Program in preparation.

The Central Association of Science and Mathematics Teachers *invites you* to membership.

Membership fees ($3.50) annually includes subscription to the journal SCHOOL SCIENCE AND MATHEMATICS, also, free admission to all convention programs.—Fee for visitors and guests $1.50.

J. E. POTZGER, President 1948
Butler University, Indianapolis

BOOKS RECEIVED

HIGHER ALGEBRA, A SEQUEL TO HIGHER ALGEBRA FOR SCHOOLS, by W. L. Ferrar, M.A., D.Sc., *Fellow of Hertford College, Oxford*, Cloth. Pages vi+320. 13.5×21.5 cm. 1947. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $5.00.

RIDDLE IN MATHEMATICS, A BOOK OF PARADOXES, by Eugene P. Northrop. Fifth Printing. Cloth. Pages viii+262. 13×21.5 cm. 1944. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.50.

MATHEMATICS FOR USE IN BUSINESS, by C. E. Hilborn, *Duquesne University, Director of Research, W. S. Hill Company*. Cloth. Pages vii+472. 14×21.5 cm. 1948. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $3.50.

ESSENTIALS OF RADIO, by Morris Slurzberg, B.S., M.A., *Instructor of Radio and Electronics, Jersey City Vocational High School and Jersey City Vocational Evening School, Trade Extension Courses;* and William Osterheld, B.S., M.A., *Instructor of Electricity and Radio, Wm. L. Dickinson High School, Jersey City.* Cloth. Pages xii+806. 15×23 cm. 1948. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $4.00.

CHEMICAL RUSSIAN, SELF-TAUGHT, by James W. Perry, *Massachusetts Institute of Technology, Cambridge, Mass.* Cloth. Pages vii+221. 1948. Journal of Chemical Education, 20th and Northampton Street, Easton, Pa. Price $3.00.

MATHEMATICS OF FINANCE, by J. B. Linker and M. A. Hill, Jr., *University of North Carolina*. Cloth. Pages viii+175+83. 13.5×21.5 cm. 1948. Henry Holt and Company, 257 Fourth Avenue, New York 10, N. Y. Price $2.90.

ANIMAL BIOLOGY, by Michael F. Guyer, *University of Wisconsin*. Fourth Edition. Cloth. Pages xvii+780. 15.5×23.5 cm. 1948. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $4.50.

TEXTBOOK OF CHEMISTRY, by Albert L. Elder, *Director of Research, Can Products Refining Company;* Ewing C. Scott, *Associate Professor of Chemistry, Syracuse University;* and Frank A. Kanda, *Assistant Professor of Chemistry, Syracuse University*. Revised Edition. Cloth. Pages viii+758. 15.5×23.5 cm. 1948. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $4.50.

INTRODUCTION TO THE DIFFERENTIAL EQUATIONS OF PHYSICS, by L. Hopf, *Professor at the Aachen Institute of Technology*. Translated by Walter Nef, *Professor at the University of Fribourg, Switzerland*. Cloth. Pages v+154. 10.5×16.5 cm. 1948. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price $1.95.

THE ELECTRON MICROSCOPE, by Dr. D. Gabor, *Engineer, British Thomson-Houston Company, Ltd., Research Laboratory, Rugby*. Cloth. Pages viii+164. 13.5×20.5 cm. 1948. Chemical Publishing Company, Inc., Brooklyn 2, N. Y. Price $4.75.

GENERAL AND APPLIED CHEMISTRY, by Arnold J. Currier, *Associate Professor of Chemistry, The Pennsylvania State College*, and Arthur Rose, *Associate Professor of Chemical Engineering, The Pennsylvania State College*. Cloth. Pages ix+275. 15×23 cm. 1948. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $3.00.

THE EARTH AND ITS RESOURCES, by Vernor C. Finch, *Professor of Geography, University of Wisconsin;* Glenn T. Trewartha, *Professor of Geography, University of Wisconsin;* and M. H. Shearer, *Westport High School, Kansas City, Missouri*. Second Edition. Cloth. Pages viii+584. 15.5×23.5 cm. 1948. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 18, N. Y. Price $3.20.

PHYSICS, A BASIC SCIENCE, by Elmer E. Burns, *Teacher of Physics (Emeritus), Austin High School, Chicago:* Frank L. Verwiebe, *Research Physicist, Applied Physics Laboratory, The Johns Hopkins University;* and Herbert C. Hazel, *Formerly Head of Science Department, Bloomington, Indiana High School.* Second Edition. Cloth. Pages xii+674. 15×25 cm. 1948. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York 3, N. Y. Price $2.88.

A MODERN COURSE IN TRIGONOMETRY, by Alfred Hooper, *formerly Headmaster of Hillstone Preparatory School, Malvern, England,* and Alice L. Griswold, *Garden City High School, New York.* Cloth. Pages xiii+300+101. 13.5×21 cm. 1948. Henry Holt and Company, Inc., 257 Fourth Avenue, New York, N. Y. Price $2.52.

ASTRONOMY, A TEXTBOOK FOR COLLEGES, by William Lee Kennon, Ph.D., *Professor of Physics and Astronomy in the University of Mississippi.* Cloth. Pages vii+737. 15.5×23 cm. 1948. Ginn and Company, Statler Building, Boston 17, Mass. Price $5.50.

MATHEMATICS: OUR GREAT HERITGAGE. ESSAYS ON THE NATURE AND CULTURAL SIGNIFICANCE OF MATHEMATICS. Selected and Edited by William L. Schaaf, Ph.D., *Department of Education, Brooklyn College.* Cloth. Pages xi+291. 13.5×21 cm. 1948. Harper and Brothers, 49 East 33rd Street, New York 16, N. Y. Price $3.50.

THE CHEMICAL FORMULARY. A COLLECTION OF VALUABLE, TIMELY, PRACTICAL COMMERCIAL FORMULAE AND RECIPES FOR MAKING THOUSANDS OF PRODUCTS IN MANY FIELDS OF INDUSTRY. Volume VIII. Editor-in-Chief, H. Bennett. Cloth. Pages xxvi+448. 14×21 cm. 1948. The Chemical Publishing Company, Inc., 26 Court Street, Brooklyn 2, N. Y. Price $7.00.

UNDERSTANDING SCIENCE, by William H. Crouse, *Editor, Technical Books McGraw-Hill Book Company, Inc.,* Cloth. Pages viii+190. 14.5×22.5 cm. 1948. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 18, N. Y. Price $2.20.

OUTLINE OF PHYSIOLOGY, by William R. Amberson, Ph.D., *Professor of Physiology, University of Maryland,* and Dietrich C. Smith, Ph.D., *Associate Professor of Physiology, University of Maryland.* Second Edition. Cloth. Pages xi+502. 17×25.5 cm. 1948. Appleton-Century-Crofts, Inc., 101 Fifth Avenue, New York 3, N. Y. Price $5.00.

COLLEGE PHYSICS, by Henry A. Perkins, Sc.D., *Professor of Physics, Emeritus, Trinity College.* Third Edition. Cloth. Pages x+786. 14.5×23 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $6.65.

BOOK REVIEWS

WHOM THE GODS LOVE. THE STORY OF EVARISTE GALOIS, by Leopold Infeld. Cloth. Pages ix+323. 13.5×20.5 cm. 1948. Whittlesey House, McGraw-Hill Book Company, Inc., New York 18, N. Y. Price $3.50.

This is a little book on the life of a man to whom the Encyclopaedia Britannica can devote but a few lines. It is true that much of the story given here is the attempt of the author to "fill in" a continuous account of the important years of a short life. It is his picture of the life of a brilliant student in a politically troubled France in the early part of the 19th century. But the story is of a most unusual student. Little is actually known of the part taken by Evariste Galois in the few short years of his life or in the details of his death. His great contributions to the field of mathematics were gathered from papers left on his table the night

before he fell in a duel. Little is known of the actual development of the work for which he is now remembered. Much more is filled in by the vivid imagination of the author and his skill as a writer of the part taken by the young student of mathematics in the turmoil of Paris during the reign of Louis Philippe. The author has done some bold guessing after making a thorough study of all available literature. It does not all check with the account written by Dupuy, but he spent considerable time and energy in hunting the facts that are known and in checking the suppositions and guesses made by others. The result is a most interesting story of the short life of a brilliant master of theory. All students of mathematics will want to read it.

G. W. W.

A LABORATORY MANUAL OF VERTEBRATE EMBRYOLOGY: ANATOMY OF SELECTED EMBRYOS OF THE FROG, CHICK AND PIG, by F. B. Adamstone, Ph.D., and Waldo Shumway, Ph.D., *both Professors of Zoology at the University of Illinois.* Second edition. Looseleaf, paperbound. Pages vii+96. 23.0×14.5 cm. 1947. John Wiley & Sons, Inc., New York.

Ten years of experience in teaching embryology resulted in a new approach to presenting this subject, which Dr. Adamstone embodied in a manual on the chick and the 10-mm. pig. After using for a year, the original work was enlarged and a chapter devoted to the anatomy of frog embryos added. This is the second edition of the joint work of the two authors in which errors have been corrected and new approaches to difficult portions instituted.

There are 38 figures either made by the authors from actual specimens or from wax model reconstructions made by students in their classes.

The plan of the work is a combination of the old approach of "drawing a few individual and supposedly representative sections" and a new one instituted by them of making a thorough careful study of the anatomy of certain developmental stages. That is, when studying the earlier, and thus simpler, stages the time-honored method of making labeled drawings is used. Space is provided, either on whole pages inserted for this purpose, or on the left-hand half of the textual material, opposite the portion of the text devoted to this subject, for making these drawings. When the embryos have become more complicated the student is required to trace the structures through the whole series of slides, keeping a record of those identified as he goes. At the end he makes a drawing of the total mount, but his success or failure is determined by individual quizzes.

This seems to be a happy solution of the question of whether to require the student to make all his own drawings or only to label those made by others. Many hours spent laboring over drawings may mean that much valuable time is lost for actual understanding of the material presented. By placing enough emphasis on drawing simpler structures and more on the sum total of knowledge gained, it would seem that the most efficient use of time allotted has been made.

H. F. W.

GUIDE TO THE STUDY OF THE ANATOMY OF THE SHARK, NECTURUS, AND THE CAT, by Samuel Eddy, *Professor of Zoology, University of Minnesota;* Clarence P. Oliver, *Professor of Zoology, University of Texas;* and John P. Turner, *late Assistant Professor of Zoology, University of Minnesota.* Second edition. Looseleaf, paperbound. Pages vii+115. 23.0×14.5 cm. 1946. John Wiley & Sons, Inc., New York. Price, $2.00.

ATLAS OF OUTLINE DRAWINGS FOR VERTEBRATE ANATOMY, by the same authors. Similarly bound. Pages perforated for removal and punched for 2-hole 8½×11 inch laboratory notebook. Pages vii+80. 28.0×21.5 cm. 1946. John Wiley & Sons, Inc., New York. Price, $2.00.

These companion volumes, one a laboratory guide and the other comprising a series of 80 outline drawings of vertebrate systems and structures, were originally

published in 1940. These new editions include more material, while some of the old has been revised. While the Atlas stresses mostly the forms mentioned in the title of the Guide, it includes a series of 8 drawings of cross and longitudinal sections of Amphioxus and four of the skulls of the sturgeon, gar and bowfin. The authors have made the excellent drawings from dissections to be labeled by the students. The Atlas is provided to alleviate much laborious drawing in an otherwise crowded course in vertebrate anatomy, so that more time may be spent doing the actual dissection. However, no leaders for labeling are provided. This is to "avoid excessive standardization and to leave some initiative to the student." Muscle drawings for Necturus and the cat are included, but none of the dogfish.

The Guide gives explicit directions for the dissections and includes 17 figures completely labeled, some of them exact duplicates of the unlabeled drawings in the Atlas. While there are only a few such duplications, the authors might have called forth still more initiative on the part of the student by showing these structures in a slightly different view. If stress is placed on demonstrations with the student's own dissection, instead of a well-prepared notebook, objections such as the one mentioned and any that might be made about doing the student's drawing for him are easily met.

H. F. W.

MODERN MATHEMATICS, by S. A. Walling, *Senior Master R.N. (ret.)* and J. C. Hill, B.A. *(Cantab.) Education Department, Cambridge University Press.* Cloth. Pages vi+153. 12.5×19.5 cm. The Macmillan Company, 60 Fifth Avenue, New York, N. Y. Price $1.00.

This little book contains brief explanations of several of the more elementary mathematical processes, ranging from fractions, decimals, through graphs, elementary geometry, logarithms, trigonometry and the slide rule. The discussion is followed by problems which have been classified into five types depending upon vocational or occupational interest.

The text is planned for English students, and hence would probably not be suitable for a text in schools in the United States. It might be of interest as a library reference, or as a source of supplementary problem materials. Students in the upper grades would doubtless be interested in certain English customs and usages, such as the position of the decimal point, the use of such terms as lorry, petrol, permanent way of a railroad, accumulator, etc. Financial calculations are of course in English units. Usage in the field of business in this country is no longer in agreement with the statement in this text that 'per centages showing comparisons of increase or decrease of output, etc., are *always* based upon the original figure and not the final one.'

CECIL B. READ
University of Wichita

A PHILOSOPHY OF MATHEMATICS, by Louis O. Kattsoff, *Associate Professor of Philosophy, University of North Carolina.* Cloth. Pages ix+266. 15×22 cm. 1948. The Iowa State College Press, Ames, Iowa. Price $5.00.

The teacher who at some mathematical conference has listened to a discussion concerned with the content and methods of teaching of certain mathematics courses, the discussion topic being stated as *A philosophy of mathematics* will no doubt be surprised if he examines a copy of this book. The purpose of the text, which seems to be exceptionally well achieved, is to present in a single volume the ideas of various authors of mathematical philosophies. In other words, there are presented various viewpoints of the fundamental and basic concepts upon which mathematics is founded. Many of the problems which have arisen are pointed out, together with some of their implications. The text is written for the student who is well advanced in mathematical maturity, prefer-

ably with some graduate work, and who also has strong background in philosophy.

Earlier chapters treat the definition of number, the extension of the number system; later material treats logical systems proposed by various authorities, hence the text might be used in a course in symbolic logic. For the secondary school teacher, the material on "The Structure of the Mathematical System" which includes a fine discussion of the use of the definition in mathematics, would perhaps be more readable than other parts.

The book contains a rather extensive bibliography. The index is not as complete as might be, as was discovered upon attempting to again locate an interesting passage. Only one minor misprint was noted.

CECIL B. READ

IROQUOIS NEW STANDARD GENERAL MATHEMATICS, by David H. Patton, *Superintendent of Schools, Syracuse, New York*, and William E. Young, *State Education Department, Albany, New York*. Cloth. Book One, Grade Seven, pages xiii+298+48+viii. 13×19 cm. 1947. Price $1.48. Book Two. Grade Eight, pages xiii+326+52+vii. 13×19 cm. 1947. Price $1.48. Book Three, Grade Nine, pages xix+587. 13×19 cm. 1947. Price $1.96. Iroquois Publishing Company, Inc., Chimes Building, Syracuse, N. Y.

This series of three books is intended for the seventh, eighth and ninth grades of the junior high school. Book Three is also suitable for the first year in the four year high school as a course in general mathematics in place of algebra.

Book One covers seventh grade arithmetic with applications appropriate for this age level. It also contains simple geometric figures.

Book Two covers eighth grade arithmetic with applications, geometric constructions, perimeters, areas, surfaces, and volumes of geometric figures, and an introduction of algebra.

Book Three provides continued experience in the use of arithmetic, contains considerable intuitive geometry supplemented with some practice in formal proof and presents some of the basic units of first year algebra and trigonometry. There is some attempt to interrelate the arithmetic, algebra and geometry.

The presentation in these books is pleasantly direct, concise and complete; the mathematics included is comprehensive.

It would seem that more interrelation could be accomplished especially in Book Three. The arrangement is primarily a rather carefully planned rotation of units in arithmetic, algebra and geometry.

MILTON D. OESTREICHER
Francis W. Parker School
Chicago, Illinois

ADVENTURES IN ALGEBRA, FIRST COURSE, by Murray J. Leventhal, *Chairman, Mathematics Department, James Madison High School, Brooklyn, New York*, and Charles Salkind, *Samuel Tilden High School, Brooklyn, New York*. Edited by F. Eugene Seymour, Supervisor of Mathematics, State Education Department, Albany, New York. Cloth. Pages xiv+380. 15×20 cm. 1947. Globe Book Company, Inc., 175 Fifth Avenue, New York 10, N. Y. Price $1.84.

For a school offering the double-track sequence in mathematics, this text would merit consideration for use with the average or better beginning algebra student. A definite effort has been made to break away from the mechanical operations of algebra and to provide a meaningful content and operational procedures.

The opening unit deals with statistical graphs, their construction and use in relation to interpolation and measures of central tendency. A very good development of arithmetic numbers and operations follows. The function concept is introduced and is carried through in work with graphs of linear and quadratic

equations of one variable, formulas, and equation solutions. Linear equations in one variable are solved by use of axioms, with emphasis upon meaningful operations. Linear systems in two variables are solved first graphically and then analytically. Quadratics in one unknown are solved only by factoring methods. The usual work with exponents, radicals, and fractions is given at appropriate intervals.

The exercises are well graded as to difficulty and location, with more difficult "honor" work provided. Exercises point toward understanding rather than mechanical procedure. Possibly some may feel that an insufficient amount of drill material is provided. Verbal problems are not classified as to type, but are given at intervals as practice in analytical thinking. An interesting feature of these is that the problem may contain insufficient or extraneous material, and the student is warned to watch for this. The last two sections of work deal with measurement involving approximate numbers and numerical trigonometry of the right triangle, congruent, and similar triangle relations. In developing operations with approximate numbers a rather limited explanation of procedure is made, particularly with regard to the number of significant digits in a product or quotient. It is doubtful if these two units could be reached in a years work if all of the previous material is covered. A section of review problems completes the text.

The mechanical make up of the book is good, excepting the typography of the tables on powers and roots and the trigonometric functions.

For a teacher not satisfied with the cut and dried mechanical drill procedures of beginning algebra, this text will offer an opportunity to teach a meaningful course. Even though the authors state that it is written to a student level, it would seem that this text is clearly pitched to a selective group of students.

W. K. McNabb
Hockaday Junior College
Dallas 6, Texas

Bacteriology—A Textbook of Microorganisms, by Fred Wilbur Tanner *Professor of Bacteriology and Head of the Department, University of Illinois Urbana*, and Fred Wilbur Tanner Jr., *Bacteriologist, Fermentation Division, Northern Regional Laboratory, Bureau of Agricultural and Industrial Chemistry, United States Department of Agriculture, Peoria, Illinois*. Fourth Edition. Cloth. Pages x+625. 13.5×21.5 cm. 1948. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

This is the fourth edition of an extensively used college bacteriology text. The well-balanced contents of the book enhance its value for introductory courses in the science of microorganisms, for the authors depart from the natural tendency to stress pathogens and assess them solely with respect to their part in the total configuration. The many interesting, practical, and economically important aspects of the science of bacteriology are adequately introduced, but this material is not permitted to obscure the equally important fundamental facts and principles with which the student must become acquainted before he can skillfully apply the science.

In general arrangement, this new edition differs only slightly from the earlier ones. Chapters I–III present the historical development of the science, the systematic position of microorganisms with respect to other forms of life, and the functioning of the basic cell unit. Chapter IV gives a separate and detailed treatment of the ultramicroscopic forms of life: this is an added feature over the former editions. Chapter V considers the morphology of bacteria and includes descriptions not only of shape and size but also of reproduction, locomotion, and chemical composition. Chapter VI takes up the modern theories of pleomorphism and genetics. Chapter VII is on the nomenclature and classification of bacteria and has a helpful key to be used in identification.

This introductory material equips the student for more critical investigations of the subject. The molds, yeasts, and protozoa, topics of the next three chapters,

are taken up because of their close affinity to the bacterial. Chapters IX and X deal with the physical and chemical agents which affect bacterial. Chapters VII to XVI discuss in greater detail bacterial relationships and associations, nutrition and metabolism, growth, and enzymes.

The remaining fifteen chapters contain more direct descriptions of the science as it is applied. Topics considered are: the nitrogen, sulfur, and carbon cycles; pollution and purification of water; treatment of sewage; milk and its pasteurization; industrial uses of the fermenting bacteria; food preservatives, infection, and poisoning; and finally, the various disease transmitting bacteria.

The text is admirably well organized for class work, and pertinent new material has been inserted to bring this edition up-to-date. Both authors are reliable, experienced authorities, the junior author contributing for the first time to this edition.

GEORGE S. FICHTER
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CHEMISTRY, A COURSE FOR HIGH SCHOOLS, by John C. Hogg, A.M., M.A. *Chairman, Science Department, The Phillips Exeter Academy, Exeter, New Hampshire;* Otis E. Alley, Ph.D., *Head of Science Department, Winchester High School, Massachusetts;* and Charles L. Bickel, Ph.D., *Instructor in Science, The Phillips Academy Exeter, New Hampshire.* Second Edition. Cloth. Pages x+555. 15×23 cm. 1948. D. Van Nostrand Company, Inc., 250 Fourth Avenue, New York, N. Y. Price $2.88.

This text is built for the conventional high school course with emphasis placed upon industrial processes. The authors believe that the ever-increasing applications of chemistry warrant a greater emphasis upon this phase of teaching.

The book has three parts: Part I is descriptive and treats the topics of coal and petroleum: Part II is theoretical and treats the ionization theory and atomic structure in quite some detail: Parg III treats the topics of metals, organic chemistry, plastics and rubber, and foods. The topic of weight calculations is treated extensively in Chapter 13, while the topic of volume calculations is treated extensively in Chapter 20.

The teacher will find some very valuable aids at the end of the chapter in the form of "Things to Remember," "Questions," and "Problems" divided into two levels of difficulty. Each unit has a comprehensive review patterned after the chapter reviews. A comprehensive six page review covering the material of the six units is provided at the end of the text. The last pages of the book contain a glossary and a good index. The last page including the cover has an excellent reproduction of the periodic chart.

The text is definitely aimed at students of better than average ability. No supplementary tables such as one usually finds in the conventional text, are provided. The authors do not provide a list of films, although this phase of work is assuming greater importance in the instructional work of teachers. The text certainly covers the field of chemistry comprehensively and in some detail. Teachers with superior groups will find the text meets their needs most adequately.

KENNETH E. ANDERSON

RIDDLES IN MATHEMATICS. A Book of Paradoxes, by Eugene P. Northrop, Pages VIII+262. 22×15 cm. 115 figures and sketches. 1944. D. Van Nostrand Company, Inc., New York. Price $3.00.

The increased use of mathematics for recreation brought about the publication of this book of approximately 200 riddles and paradoxes covering mathematics from simplest arithmetic and common sense to calculus and pure logic. Some of the answers or explanations of the paradoxes are included in the main text while others are explained in the appendix. The book contains an extensive

Table of Contents, is indexed, and includes many references to books and articles by a great variety of authors.

Many of the paradoxes are introduced by presenting their historical origin while others are introduced by leading up to them with a short story. The reader will be interested to see how the powerful theory of mathematical statistics rose from a simple dice problem, and how "a poor young graduate student, brilliant in mathematics but inexperienced in the ways of the world" bested a group of professional gamblers who had cheated him out of most of his money in a dishonest poker game.

The book would be a valuable addition to a school library for certain sections could be read by the students, mathematics teachers would find the entire book interesting, and non-mathematics teachers could find enjoyment in reading all but the last chapter.

LE ROY J. SIMON
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TAKE A NUMBER, by Lillian R. Lieber, *author of The Education of T. C. Mits* Cloth. Pages x+221. 21.5×14 cm. 49 sketches and figures by Hugh Gray Lieber. 1946. The Jaques Cattell Press, Lancaster, Pennsylvania. Price. $2.75.

In her customary free verse style of writing, Lillian R. Lieber has written another entertaining and educational book. The sketches throughout the book liven up the reading and carry a message of their own. "Take A Number," with a sub-title "Mathematics for the Two Billion," is written for those who are amazed by their clever friends who ask them to "take a number" and then proceed to read their minds.

The first chapter attempts to answer the question "Why should you study mathematics?" from the standpoint of esthetic appreciation, and introduces SAM, representing Science, Art, and Mathematics, who serves as guide throughout the book.

The basic facts of algebra are then explained by referring to them as the rules and equipment needed to play the algebra game. The treatment is quite thorough and logically presented. In the back of the book there are 18 exercises to which the reader is referred at various times in the main text. The bitter pill of drill and practice is slightly sugar-coated by the author when she explains in various ways that as you learn something new, it is necessary to try your skill at these new procedures. The answers to all problems are given, and a list of 13 formulas for areas, volumes, etc., are included. The summary at the end of the main text goes beyond the factual knowledge to include some of the appreciations from working with SAM. Noticeably missing however, is any reference as to how your friend who say "Take a number" reads your mind so easily.

The book would not serve effectively as a text, but could be used to stimulate interest, to simplfy and clarify some of the rules of elementary algebra, or to serve as a review.

LE ROY J. SIMON

STARLINGS, by Wilfred S. Bronson. Cloth. Pages 76. 15×20 cm. 1948. Harcourt, Brace and Company, 383 Madison Ave., New York 17, N. Y. Price $2.00.

The book champions the cause of the starling. It is profusely illustrated by the author, perhaps two-thirds of most pages is given to illustrations. These are presented in a manner to tell as much of the story as the printed words. Many of the illustrations are held in a humorous vein. The book presents the history of the introduction of the starling into the United States, its habits, objectionable characteristics and the persecution it suffers. The report differs from the customary criticism of the bird by pointing out its many beneficial activities. One

of these is its presence in winter in temperate regions when life activity is at low ebb, its beautiful song (subdued) at all seasons of the year, and feeding on many destructive insects. The book also devotes several pages to anatomy of birds, nest building and feeding of young. It is a very readable book, with fine humor, and with clear, living illustrations. The whole book can be read in a few hours, and it is suited especially for children.

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WORKBOOKS AND MANUALS

CROW ROTATING ELECTRIC MACHINE, by Col. Kenneth Zitzman, *Signal Corps, U. S. Army, Associate Professor, Department of Electricity of the United States Military Academy, West Point, New York.* Paper. Manual of 94 pages. 20.5×28 cm. 1947. Universal Scientific Company, Inc., 1102 Shelby Street, Vincennes, Ind.

A complete, highly illustrated manual showing how to use the Crow Machine. You cannot afford to be without the manual if you have the machine; when you see the manual you will want the machine.

PHYSICAL SCIENCE MADE EASY, QUESTIONS, ANSWERS, AND DEFINITIONS, by Theodore G. Phillips, *Department of Physical Sciences, Chicago City Colleges, Lecturer in Physical Sciences, Roosevelt College of Chicago;* and William Colburn *Department of Physical Sciences, Roosevelt College of Chicago.* Paper. 346 pages. 14.5×22 cm. 1948.

A great help for your college physical science students. It consists of a Glossary of Terms. Biographical Sktches, List of Important Equations, Other Useful Information including Physical Constants, Conversion Factors, Geological Time Table, Diagrammatic Summary of Periodic Table Relations. The last 203 pages consist of questions and answers to a survey of the physical sciences.

MECHANICAL DRAFTING ESSENTIALS. TECHNICAL SKETCHING, MECHANICAL DRAFTING, BLUE PRINT READING, by Walter E. Farnham, *Tufts College Engineering School,* and Francis T. McCabe, *Rindge Technical School.* Paper. 196 pages. 21×28 cm. 1948. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $2.75.

A combination workbook and textbook for an introductory course in technical schools. This is a new type book based on the latest methods of teaching.

LABORATORY CHEMISTRY, by William E. Price, *Department of Chemistry, Clifford J. Scott High School, East Orange, New Jersey.* Kraft. Pages x+133.21×26 cm. 1947. World Book Company, Yonkers-on-Hudson, N. Y. Price 92 cents.

This gives a few pages of excellent suggestions on how to be a good laboratory worker, a set of preliminary exercises, a list of forty-eight experiments with questions and space for answers. Fourteen project experiments are briefly outlined and a three page appendix of important information follows.

INORGANIC CHEMICAL NOMENCLATURE, by Lloyd McKinley, *Professor of Chemistry, University of Wichita.* Paper. 40 pages. 21×27.5 cm. 1947. University of Wichita Bookstore, Wichita, Kansas. Price 35 cents. In lots or more 28 cents.

An elementary manual emphasizing rules for naming compounds and writing formulas; designed for supplementing textbooks of general chemistry and qualitative analysis. It gives real help on a difficult phase of chemistry.

SEMIMICRO LABORATORY EXERCISES IN HIGH SCHOOL CHEMISTRY, by Fred T. Weisbruch, M.S., *Head of the Science Department, William Cullen McBride High School, St. Louis, Missouri.* Paper. Pages iii+269. 20.5×27 cm. 1946. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price. $1.48.

A set of sixty-two exercises with space provided for recording data and answers to questions, followed by self-testing exercises.

BIOLOGY LABORATORY NOTEBOOK, by Sol. M. Rudin, MS., *Instructor in Science, New York City Schools,* and Peter Greenleaf, MA., *Chairman, Science Department, Eron Preparatory School, New York City.* Paper. 144 pages. 20.5×27 cm. 1946. Globe Book Company, Inc., 175 Fifth Avenue, New York 10, N. Y. Price in quantities of 10 or more copies 90 cents.

Sixty-six laboratory exercises prepared for use with any standard biology text. Designed to assist the student in discovering for himself the fundamental facts and present theories of biology. This text has been built up from daily use by the authors.

WORKBOOK FOR SCIENCE ON THE MARCH, Book One, by Curtis Love, *Head of the Science Department, Pine Bluff High School, Pine Bluff, Arkansas;* and John A. Clark, *Head of Department of Physical Sciences, Alexander Hamilton High School, Brooklyn, New York.* Paper. 170 pages. 19.5×28 cm. 1947. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price 96 cents.

A book "to make the task of the teacher easier and to make the work of the pupil more effective." Eight fundamental units each divided into several problem-questions. Well illustrated and many good questions that may be answered briefly.

SCIENCE THROUGH EXPERIMENT, A General Science Workbook by Charles H. Lake, Louis E. Welton and James C. Adell, *all of the Cleveland Public Schools.* Paper. Pages viii+264. 19.5×26 cm. 1947. Silver Burdett Company. 45 East 17th Street, New York 3, N. Y. Price $1.24.

Fifteen units of several problems each. Illustrated by drawings, pictures, and maps. Good questions with space for inserting brief answers. Suggestions for things to do, good references for reading and study. Excellent lists of questions for study.

BASIC MATHEMATICS, A WORKBOOK, by M. Wiles Keller, Purdue University, and James H. Zant, Oklahoma Agricultural and Mechanical College. Paper. Pages v+253. 20.5×28 cm. 1948. Houghton Mifflin Company, 2 Park Street, Boston, Mass. Price $1.50.

An excellent review of all the essentials of elementary mathematics. It is designed to provide an appreciation of the subject, to furnish some of the basic essentials for practical courses, and to give a review of forgotten material.

Consists of both diagnostic and achievement tests covering quite thoroughly the subjects of arithmetic, algebra, and trigonometry. Designed for students who are planning to do more advanced work in mathematics and need a review.

WORKBOOK IN GENERAL MATHEMATICS: BASIC COURSE, by Raleigh Schorling, John R. Clark, and Francis G. Lankford, Jr. 162 pages. 21×26 cm. 1948. World Book Company, Yonkers-on-Hudson, N. Y. Price 68 cents.

Thirteen units covering the fundamental processes in arithmetic, algebra, geometry, and trigonometry. Clear diagrams, ample space for student work, orderly arrangement are important features.